DESIGN OF A HEAVY-SECTION FRACTURE TESTING MACHINE

END OF PHASE TWO REPORT

June, 1983

SRC Publication No. I-4304-3-C-83

DESIGN OF A HEAVY-SECTION FRACTURE TESTING MACHINE

END OF PHASE TWO REPORT

SASKATCHEWAN RESEARCH COUNCIL
PRODUCT AND PROCESS DEVELOPMENT GROUP
INDUSTRIAL TECHNOLOGY TRANSFER

JUNE, 1983

Work on this project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources, Canada.

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
RN : 23440-1-9069
FC : 213-131-000000-420604-0433
CANMET PROJECT NUMBER : 420604
CANMET SCIENTIFIC AUTHORITY : Mr..Tyson
SRC PROPOSAL : I-4301-I-F-82
SRC PROJECT MANAGER : A.D. Malinoski, P.Eng.

144 pp

MICROMEDIA
DEC 22 1983

ACKNOWLEDGEMENTS

This report was prepared for CANMET by Allan Malinoski[1], Don Ireland[2], and C.W. Tellefson[3]. Typing was by Fiona Popoff and Gwen Calderon.

We wish to thank the following individuals for giving SRC the opportunity to perform this work.

SCIENTIFIC AUTHORITY

Mr. W. Tyson
Department of Energy, Mines and Resources
CANMET, Physical Metallurgy Research Laboratories
568 Booth Street
Ottawa, Ontario
K1A 0G1

SCIENCE PROCUREMENT MANAGER

Mr. J.W. McGill
Department of Supply and Services
Science Centre
11C1 Place du Portage
Phase III
11 Laurier Street
Hull, Quebec
K1A 0S5

---

[1] Senior Research Scientist, Saskatchewan Research Council, Saskatoon, Saskatchewan (306)664-5795.

[2 & 3] Ireland and Associates, Santa Barbara, California (805) 569-1028

CONTENTS

1. EXECUTIVE SUMMARY
2. SPECIMEN REQUIREMENTS

   SPECIFICATIONS ON TUP INSTRUMENTATION, DATA ACQUISITION AND PROCESSING HARDWARE

3. SYSTEM CHECKOUT AND CALIBRATION
4. DETAILED ENGINEERING DRAWINGS OF STRUCTURAL AND MECHANICAL SYSTEMS, WITH DISCUSSION
5. SUMMARY OF RECOMMENDED OFF THE SHELF COMPONENTS AND PREFERRED SUPPLIERS, PLUS KEY REFERENCE LITERATURE DESCRIPTION
6. FOUNDATION RECOMMENDATIONS

FIGURE AND/OR DRAWING	TITLE	PAGE NUMBER
Figure 1	ANVIL AND TUP REQUIREMENTS FOR DYNAMIC TEAR SPECIMENS RANGING FROM ASTM E604 TO 50 MM THICKNESS	2-4
Figure 2	BLOCK DIAGRAM FOR TYPICAL AUTOMATED INSTRUMENTED IMPACT SYSTEM	2-10
3001	DROP TOWER CONSOLE	4-9
3002	CONTROL SCHEMATIC - DROP TOWER CONSOLE	4-37
2017-1	PARTS LIST - FRACTURE TESTING MACHINE ASSEMBLY	4-39
2017-2	PARTS LIST - FRACTURE TESTING MACHINE ASSEMBLY	4-40
2017-3	PARTS LIST - FRACTURE TESTING MACHINE ASSEMBLY	4-41
2017-4	PARTS LIST - FRACTURE TESTING MACHINE ASSEMBLY	4-42
2017-5	PARTS LIST - FRACTURE TESTING MACHINE ASSEMBLY	4-43
2019-1	PARTS LIST - INSTALLATION - TUP AND ANVIL	4-43a
2001	HOISTING MECHANISM	4-44
2002	INSTALLATION - LATCH MECHANISM AND LOCK CYLINDERS	4-45
2003	LATCH FRAME WELDMENT	4-46
2004	LATCH HOOK DETAILS	4-47
2005	LATCH DETAILS	4-48
2006	CYLINDERS	4-49
2007	HOIST DETAILS	4-50
2008	CROSSHEAD DETAILS	4-51
2009	HAMMER WELDMENT	4-52
2010	HAMMER DETAILS	4-53

continued

FIGURE AND/OR DRAWING	TITLE	PAGE NUMBER
2011	STIFFENER FRAME	4-54
2012	COLUMN ASSEMBLY	4-55
2013	COLUMN DETAILS	4-56
2014	BASE WELDMENT	4-59
2015	FOUNDATION	4-60
2016	LINEAR TRANSDUCER INSTALLATION	4-61
2017	FRACTURE TESTING MACHINE ASSEMBLY	4-62
2018	HAMMER ASSEMBLY	4-63
2019	INSTALLATION - TUP AND ANVIL	4-64
2020	DETAILS - TUP AND ANVIL	4-65

ERRATA

SRC Publication No. I-4304-3-C-83
DESIGN OF A HEAVY SECTION FRACTURE
TESTING MACHINE - END OF PHASE TWO
REPORT

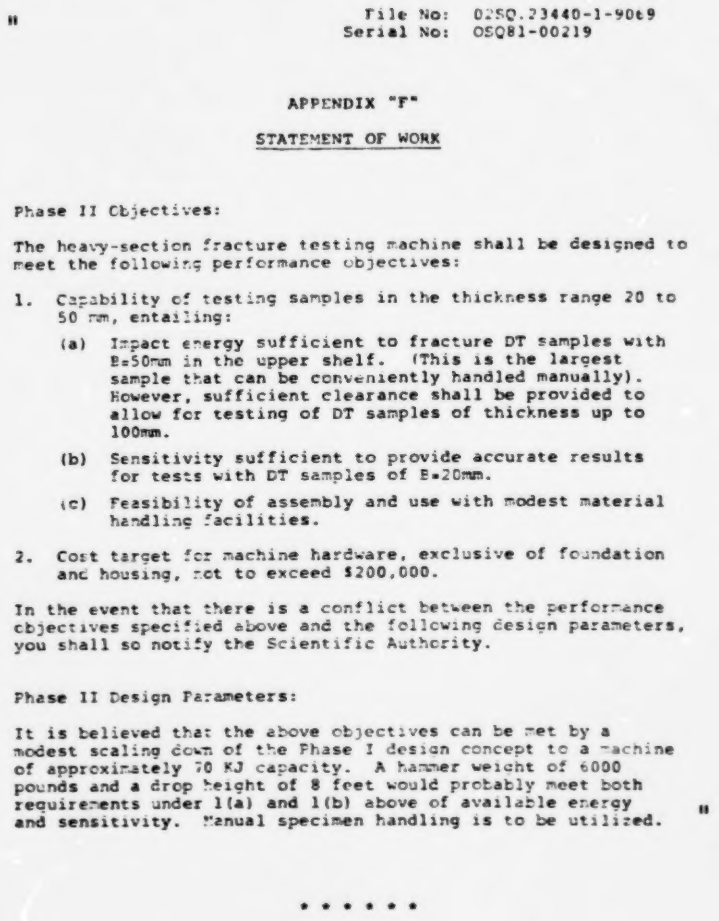
PAGE	
1 - 4 i)	Each control set consists of 5 buttons,
2 - 9 Reference 1	Pre-cracked Specimens
2 - 9 Reference 2	Notched and Precracked Specimens
6 - 3	Decelerations over 2 g's

1. EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This final report summarizes the work done in Phase II of DSS contract, DESIGN OF A HEAVY-SECTION FRACTURE TESTING MACHINE, contract serial number 0SQ81-00219.

The Phase II objectives are summarized by quoting from APPENDIX "F" of the CONTRACT AMENDMENT of January 13, 1983:



"

File No: 02SQ.23440-1-9069
Serial No: 0SQ81-00219

APPENDIX "F"

STATEMENT OF WORK

Phase II Objectives:

The heavy-section fracture testing machine shall be designed to meet the following performance objectives:

1. Capability of testing samples in the thickness range 20 to 50 mm, entailing:
    (a) Impact energy sufficient to fracture DT samples with B=50mm in the upper shelf. (This is the largest sample that can be conveniently handled manually). However, sufficient clearance shall be provided to allow for testing of DT samples of thickness up to 100mm.
    (b) Sensitivity sufficient to provide accurate results for tests with DT samples of B=20mm.
    (c) Feasibility of assembly and use with modest material handling facilities.
2. Cost target for machine hardware, exclusive of foundation and housing, not to exceed $200,000.

In the event that there is a conflict between the performance objectives specified above and the following design parameters, you shall so notify the Scientific Authority.

Phase II Design Parameters:

It is believed that the above objectives can be met by a modest scaling down of the Phase I design concept to a machine of approximately 70 KJ capacity. A hammer weight of 6000 pounds and a drop height of 8 feet would probably meet both requirements under 1(a) and 1(b) above of available energy and sensitivity. Manual specimen handling is to be utilized. "

* * * * * *

In Phase I of the contract, SRC obtained information on other large impact machines used elsewhere in the world and, on the basis of the information found and their own ideas, proposed a design for a 150 kILJOULE impact machine.

The findings are summarized in

a) DESIGN OF AHEAVY-SECTION FRACTURE TESTING MACHINE
END OF PHASE ONE REPORT
August, 1982
SRC Publication No. I-4304-1-C-82

b) DESIGN OF A HEAVY-SECTION FRACTURE TESTING MACHINE
END OF PHASE ONE REPORT
SUPPLEMENTAL - COST CONSIDERATIONS
August, 1982
SRC Publication No. I-4304-2-C-82

The reasons for undertaking Phases I and II are summarized by APPENDIX "A" from the DSS REQUEST FOR PROPOSAL.

" APPENDIX "A"

STATEMENT OF WORK:

Background:

The cold environment in which structures and vessels will operate in the Arctic and Canadian offshore require that the fracture properties of the steels used be understood completely. Most fracture testing is done using small specimens cut from plate although it is well known that the properties determined on these specimens are not directly applicable to thick plate. It is imperative that the relationship between the fracture properties of small specimens and full plate thickness specimens be known. This will require the development of a high capacity impact testing machine for use by Canadian industry.

WORK STATEMENT:

The potential contract will be divided into two phases. Phase I will comprise the development of a design concept and Phase II the preparation of a detailed engineering design.

In Phase I the contractor will obtain information on other large impact machines used elsewhere in the world and, on the basis of this information and his own ideas, propose a design for a 150 kj (110,000 ft-lb) impact machine. The machine will probably be of the drop weight variety but other concepts (pendulum) should be considered. The machine should have several ranges of maximum energy between 10 kj and 150 kj. Sensitivity of measurement of absorbed energy shall be ± 2% in each range.

Specimen dimensions will normally be wx4wx12w with a single-edge notch across the short transverse direction (crack propagation in the long transverse direction). The Specimen width w will normally range from 25 mm to 75 mm but provision should be made for testing specimens up to 150 mm thick with dimensions wx2wx6w. The machine must be designed for rapid loading of specimens (to prevent temperature changes of the specimens) and should be equipped with a hoist or manipulator capable of handling specimens of 360 kg.

Provision shall be made for full instrumentation of the loading tup so that load and tup displacement may be recorded during impact and the information stored for retrieval and processing.

In general, the machine should be designed as compactly as possible and designed to minimize the shock loading of the building housing the machine.

Phase II of the contract will consist of the preparation of a detailed engineering design and the specification of an instrumentation package, showing itemized costing and source.

The design shall be sufficiently detailed and documented so as to enable the Crown to call tenders for the fabrication, instrumentation, and commissioning of the unit.

NOTE: ASTM E604-77, Dynamic Tear Energy of Metallic Materials describes the type of test procedure that would be followed using this machine. However, E604-77 deals with much smaller specimens.

The contractor will provide a written report at the end of Phase I and present a seminar at PMRL outlining his proposed design. One copy of all visual aids used in this seminar will be provided to the laboratory for their retention.

A final report will be prepared at the end of the contract. Twenty-five (25) copies of all reports will be required. "

The fracture testing machine assembly is illustrated by SRC dwg. 2017 (enclosed). The overall dimensions are as follows:

width (base weldment) = 110.0" (2794 cm)
depth (base weldment) = 72.0" (1828.8 cm)
height (bottom of base weldment to top of crosshead drive motor assembly) = 262.0" (6655.1 cm)

The assembly is free standing and consists of:

a) Foundation (SRC dwg. 2015)
The 300,000 lb. concrete weight is based on the sizing formula of 50 x 6,000 lbs. where 6,000 lbs. equals the contract required nominal hammer (drop weight) weight. As discussed in Section 6 - Foundation Recommendations, additional below foundation support may be necessary depending on soil conditions at the CANMET installation site.

b) Base Weldment (SRC dwg. 2014)
This stress relieved weldment is bolted and grouted to the foundation. In turn, the following components bolt to the machined top surface:
    c) Column Assemblies, 2 of (SRC dwg. 2012)
    d) Stiffener Frame Assemblies (SRC dwg. 2011)
    e) QMS Transducer Bracket Assembly (SRC dwg. 2016)
    f) Anvils Assembly (SRC dwg. 2019)
    g) TAYLOR DEVICES SHOCK ABSORBERS, 2 of - 4 x 8, No. 67SS-12583-010

h) Hoisting Mechanism (SRC dwg's 2001, 2002, 2008, 2009)
This consists of a two speed electric drive which splits power equally through a gear box and drives two ball screw jacks. The jacks raise and lower a crosshead (dwg. 2008). The crosshead has a toggle release mechanism (dwg. 2002) which contains the hammer (dwg. 2009). The two speeds for crosshead rise and descent are 100.66 inches/minute and 9.74 inches/minute.*

i) Control Console (SRC dwg. 3001)
The crosshead has an effective setable drop height range of 0 - 8 feet. At the end of travel, top and bottom, there are limit switches which depower the drive. There are separate controls for the higher crosshead travel speed (MAIN MOTOR) and lower crosshead travel speed (MICROSPEED MOTOR). Each control set consists of 4 buttons, STOP, UP, JOG UP, DOWN, JOG DOWN. Pressing UP or DOWN and releasing the button means the crosshead will move until it hits an end of travel limit or the STOP button is pressed. Pressing JOG UP or JOG DOWN means that the crosshead only moves when the button is depressed. When you release the button, the crosshead stops.

---

* Lower crosshead travel speed using a 10:1 intermediate gear box. Slower speeds are possible by using higher reduction ratio intermediate gear boxes.

There are two types of crosshead position gauges. The absolute position gauge indicates the position of the crosshead continuously relative to the upper and lower limit position. The floating indicator is required for setting desired drop heights. For example, if a 100 mm deep specimen is to be fractured, the zero position at the top of the specimen can be established by placing a dummy aluminum (lightweight) block of 100 mm depth on the anvils. Once near the anvils, the microspeed motor advance will allow precise positioning of the TUP on the dummy block surface. Then press reset on the QMS 4051 digital console. Select metric or imperial readout. Now raise the hammer to the required drop height by watching the digital readout follow the upward travel. If a solitary operator must handle this positioning, a useful, inexpensive addition would be a remote pendant for microspeed motor control, i.e. JOG UP and JOG DOWN. This would be a parallel tie-in with the control console. With this pendant control, the operator could be immediately adjacent to the anvils and watch the TUP descent at his eye level.

There are five pneumatic cylinders in the fracture testing machine. Two are the FRAME/CROSSHEAD lock cylinders. Another two are the CROSSHEAD/HAMMER lock cylinders. When the four cylinders are engaged, the hammer, crosshead and frame are locked together by the cylinder rods which act as shear pins. In this mode it is safe to work around the anvils under the hammer. The last cylinder is the LATCH TRIP cylinder. It controls the hammer release toggle assembly. Any cylinder position at any time will be maintained during a power failure. The control console indicates cylinders positions. Also, the lock cylinders have double end rods allowing for visual inspection of any cylinder position.

The instrumentation for the proposed drop weight test facility consists of the components necessary to provide complete records of the load and absorbed energy as functions of time during the impact deformation/fracturing of the test specimens. The basic components are commercially available and have been successfully employed for instrumented impact testing.

The instrumentation consists of: an instrumented tup for sensing the applied load, a dynamic response module for load signal acquisition and analysis, and a printer for producing complete graphical and tabular records of the test results. The general operation and appearance of the system is very similar to that of the common personal computer, that is, a large CRT terminal with keyboard for operator communication. Provision is provided for permanent storage and retrieval of raw test data. Sophisticated analysis software is built in, thereby, providing an easy-to-operate and maintain system.

2. SPECIMEN REQUIREMENTS

SPECIFICATIONS ON TUP INSTRUMENTATION, DATA ACQUISITION AND PROCESSING HARDWARE

SPECIMEN REQUIREMENTS

SPECIFICATIONS ON TUP INSTRUMENTATION, DATA ACQUISITION AND PROCESSING HARDWARE

The discussion under SPECIMEN is intended to provide the necessary background information for the specifications for ANVILS and TUPS.

The requirements for ANVILS are determined by the specimen dimensions. Please note the dimensional details on Drawing No. 2019* are presented in sets which are related to a specific specimen size. If a different size is to be used, the necessary changes can be simply made to the existing drawing.

The shop details for the Tups are shown on the same drawing (No. 2020)* with that for the Anvils. The fine details required for placement of strain gages to make the tup a load transducer are not shown. This information generally is regarded as proprietary and can be supplied by the Seller. The dimensions shown for the tup are those required to satisfy mechanical considerations. The specified load capacities for three tups will provide sufficient details for defining the load transducer requirements.

The discussion under INSTRUMENTATION has been made general so as to make it possible to obtain competitive quotations. In addition, the specifications for software reflect recent experience of Ireland & Associates with a customer who has material testing interests similar to that of CANMET. The discussion and tables provide a guide for which CANMET can make changes to their specific interests.

The primary instrumentation system can be purchased from two sources, Dynatup and GHI. Instrumented Tups can be purchased from Effects Technology (Dynatup) or from a variety of other competent strain gage application companies. Please refer to the PHASE ONE SRC reports (see page 1 - 2) for background information and approximate instrumentation costs.

---

* see Section 4

SPECIMEN

The test specimen will be of the general geometry for the dynamic tear test, as described by ASTM Method E604. The specimen size is indicated by the thickness dimension (B) which is expected to vary from the 15.8 mm (for ASTM Method E604), to 50 mm, see Figure 1. Although Method E604 specified a width to thickness (W/R) ratio of 2.56, it is expected that more frequent use will be for specimens with a ratio of 2.0. The space available in the anvil area of the impact machine is sufficient for testing of specimens with thickness up to 100 mm.

The requirements for anvil supports are determined by the size of the specimen. The radius of the anvil over which the specimen will rotate during impact deformation is specified by ASTM Methods as follows:

ASTM Method	Radius
436	W/6 to W/3
604	W/3
399	W/8 minimum

The recommended anvil support radius for this impact machine is between approximately W/4 and W/3, see Figure 1.

The distance between anvil supports is defined as Span (S) and is dependant upon the Width (W) dimension of the specimen. The recommended S/W ratio for ASTM Methods E399 and E604 is 4.0. The attendant S values for dynamic tear specimens ranging in thickness from 20 to 50 mm are shown in Figure 1. The anvil supports and bottom base plate of the impact machine are designed to accommodate the specimen types shown in Figure 1. Additional specimen sizes, between thickness of 20 and 50 mm, will require only minor modification of the anvil support base to satisfy the test requirement for a Span to Width ratio of 4.0.

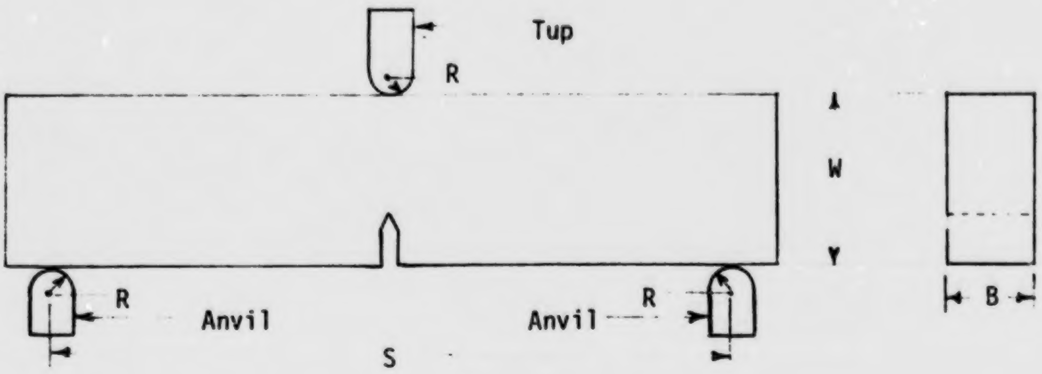
The tup requirements for dynamic tear testing are also dependant on the size of the specimen. The contact radius has the same specification as do the anvils, see Figure 1. The load capacity is dependant on the specific specimen material strength as well as the size. The maximum load (P_{max}) required to complete fracture of a specimen tested in three-point bending can be estimated from the following relationship

$$P_{max} = 0.2 B^2 \sigma_y$$

where σ_y is the appropriate uniaxial yield stress. For impact conditions, consideration must be given to possible elevation of yield stress due to the dynamic loading conditions. In addition, the useful load range for an instrumented tup is between 10 and 90 percent of rated capacity. The load capacity for tups to test dynamic tear specimens can be estimated from

$$\text{Load Capacity} = 0.45\,B^2\,\sigma_y$$

For a typical structural steel with ambient temperature uniaxial yield properties of nominal 400 MPa, the suggested tup load capacities are as shown in Figure 1. The indicated values reflect considerations for minimizing the number of tups required for specimens ranging in thickness between 20 and 50 mm.



	Specimen		Anvil		Tup	
Type	Size B (mm)	Width W (mm)	Radius R (mm)	Span S (mm)	Radius R (mm)	Load Capacity (kN)
1	15.8	38	12.7	165	12.7	72
2	20	40	12.7	160	12.7	72
3	30	60	20	240	20	162
4	40	80	20	320	20	450
5	50	100	30	400	30	450

Figure 1. ANVIL AND TUP REQUIREMENTS FOR DYNAMIC TEAR SPECIMENS RANGING FROM ASTM E604 TO 50 MM THICKNESS.

INSTRUMENTED IMPACT SYSTEM

The instrumented impact system is that portion of the machine devoted to acquisition, processing and reporting of the data required for the dynamic tear test. A block diagram for a typical system is shown in Figure 2.

The system requires two transducers. The first is a instrumented tup which can be varied (i.e., different load capacities) for variations in specimen size. This transducer senses the load applied to the specimen during the impact event. The second transducer is a velocometer system employed for measurement of hammer/tup velocity before and after impact with the specimen.

The equipment detailed in this specification shall be self-contained, and provide full capability to monitor, record, and display the dynamic behavior of a test specimen fractured in the drop weight impact machine. The equipment shall supply a precision video display and hardcopy output which can be directly analyzed as the accurate record of the load-time and energy-time history of the impact loaded specimen.

Instrumented Tups

A total of three instrumented tups are required. Each tup will have a different full scale rated capacity as follows:

1. 72 kN
2. 162 kN
3. 450 kN

In addition, these tups must satisfy the following performance and mechanical requirements:

1. A plus or minus three percent of value linear relationship between output value and applied axial load for applications between ten and ninety percent of rated capacity. Calibration records must be supplied by Seller.
2. The striking face of the tup should be variable through use of inserts with the following characteristics:
   a. Insert through section hardness of Rockwell C Scale 62 or better.
   b. Insert radius of contact with specimen variable as follows (three required):
      (i) Radius 12.7 mm ± 0.7 mm

(ii) Radius 20 mm ± 0.7 mm

(iii) Radius 30 mm ± 0.7 mm

c. The width of contact surface to be as shown in SRC Drawing No. 2020.

3. The overall tup configuration including test machine bolting attachment holes shall be of the exact form and dimensions as shown in SRC Drawing No. 2020.

4. The tup shall be instrumented with semi-conductor or foil strain gages attached to the tup according to the strain gage manufacturer instructions. These strain gages shall be carefully positioned to sense the compressive loading of the tup during the impact loading of the test piece. The gages shall be properly protected from moisture and abrasion to assure reliable and long use.

Load Signal Conditioning

A module or portion of a module to supply the tup strain gage excitation voltage, provide tup balance, provide variable load sensitivity, provide calibration functions, and to provide signal amplification and conditioning functions for further display and analysis.

Transient Signal Recorder

A digital transient recorder to supply analog to digital signal conversion, provide variable sampling rates, provide trigger control, and to provide transient data storage. The recorder shall have a 2K minimum storage capacity, and a sampling rate of up to 2MHz (minimum).

Velocometer

A non-contacting velocometer to provide triggering of the data storage device (the data storage device shall also be triggerable from the first load impulse), and to provide impact test machine pendulum velocity measurements before and after the impact event. The measured velocity values and/or raw data shall be automatically processed through Microprocessor Component for calculation of :

1. Initial Impact Velocity
2. Final Inpact Velocity
3. Total Energy Absorbed from Velocity Measurements

The calibration of this device shall be demonstrated by Seller to comply with the latest requirements of ASTM Method E604.

Dynamic Response System

This subsystem is the central data processing, communications, and reporting portion of the instrumented impact system. The minimal requirements for the system are as follows:

1. The central data processor to provide system operation, data manipulation, and analysis functions. The processor shall be equipped with a minimum of 32K of RAM memory and an IEEE-488 bus for disk and printer communications. The operator communicative language shall be BASIC.
2. A CRT keyboard and graphics terminal shall be provided for central data processor communication. A professional-type keyboard with full cursor control shall be included.
3. A 9 dot matrix printer with an 80 cps minimum print rate and bi-directional capability shall be included in the test system. The printer shall have a graph plotting option and software control of print formats. The printer shall also have both tractor and friction feed options.
4. A disk drive system shall be included in the system package and shall consist of dual floppy disk drives, power supply and interface cables. State available capacities.
5. All interfacing shall be provided with the instrumented impact test system. This includes all cabling between the tup, velocometer, transient recorder, central data processor, CRT terminal, printer, and dual disk drive components. A single master ON/OFF switch shall be included to power the system. An isolation transformer shall also be provided between the system supply power and operating components.
6. The equipment shall be furnished as either rack or bench mounted on a roll-around compact portable cabinet or desk with provisions for an operator to be seated at the CRT keyboard terminal during system operation. The equipment shall be capable of being used on more than one type of impact machine.

Software Requirements

The instrumented impact test system shall include a software package which contains at least the following:

1. Inter-component communicative ability required for successful system operation.
2. Analysis routines to determine instantaneous load and integrated energy data at cursor defined specific time intervals during the impact test event.
3. Various operator selected and system supplied parameters and calculated outputs as shown in Table I.
4. Diagnostic routines as required to assure accurate system operation and performance.
5. Provisions for operator supplied input parameters as shown in Table II.

Maintenance Requirements

The instrumented impact test system shall be covered by maintenance requirements as follows:

1. All hardware components shall have readily available maintenance/repair staff and facilities. State where located.
2. The test system supplier shall provide a complete listing of hardware component maintenance/repair facilities.
3. The test system shall include diagnostic routines of sufficient depth to enable the system operator to define the component which is not operating satisfactorily and in need of service/maintenance/repair.
4. All software related problems shall have readily available assistance provided by the system supplier or his/her designee.
5. The software shall be sufficiently defined to enable CANMET to provide modifications and troubleshootings if they so desire.

Additional Requirements

The instrumented impact test system shall be covered by the following additional requirements:

1. The Seller shall provide triplicate copies of operating manuals for the system including software definitions.
2. For each individual hardware component the Seller shall provide duplicate copies of all operating/service/ maintenance manuals including engineering drawings, part lists, and circuit diagrams which are available from the hardware component manufacturer.
3. All interface cabling and connections shall be completely defined including replacement parts lists.
4. Full system diagnostics shall be provided.
5. The Seller shall provide an instrumented tup calibration including recalibration procedures or facilities for suc[illegible]
6. The Seller shall provide any and all input factors such as system response time and filtering factors which must be entered into subsequent calculational procedures if required.

REFERENCES

1. W.F. Server, "General Yielding of Charpy V-Notch and Pre-cracked Speciments," Journal of Engineering Materials and Technology, Vol. 100, April 1978, pp. 183-188.
2. W.L. Server, "Impact Three-Point Bend Testing for Notched and Precracker Speciments," Journal of Testing and Evaluation, JTEVA, Vol. 6, No. 1, 1978, pp. 29-34.
3. ASTM E399, "Standard Test Method for Plane-Strain Fracture Toughness of Metallic Materials," American Society for Testing and Materials, Annual Book of Standards, Part 10.

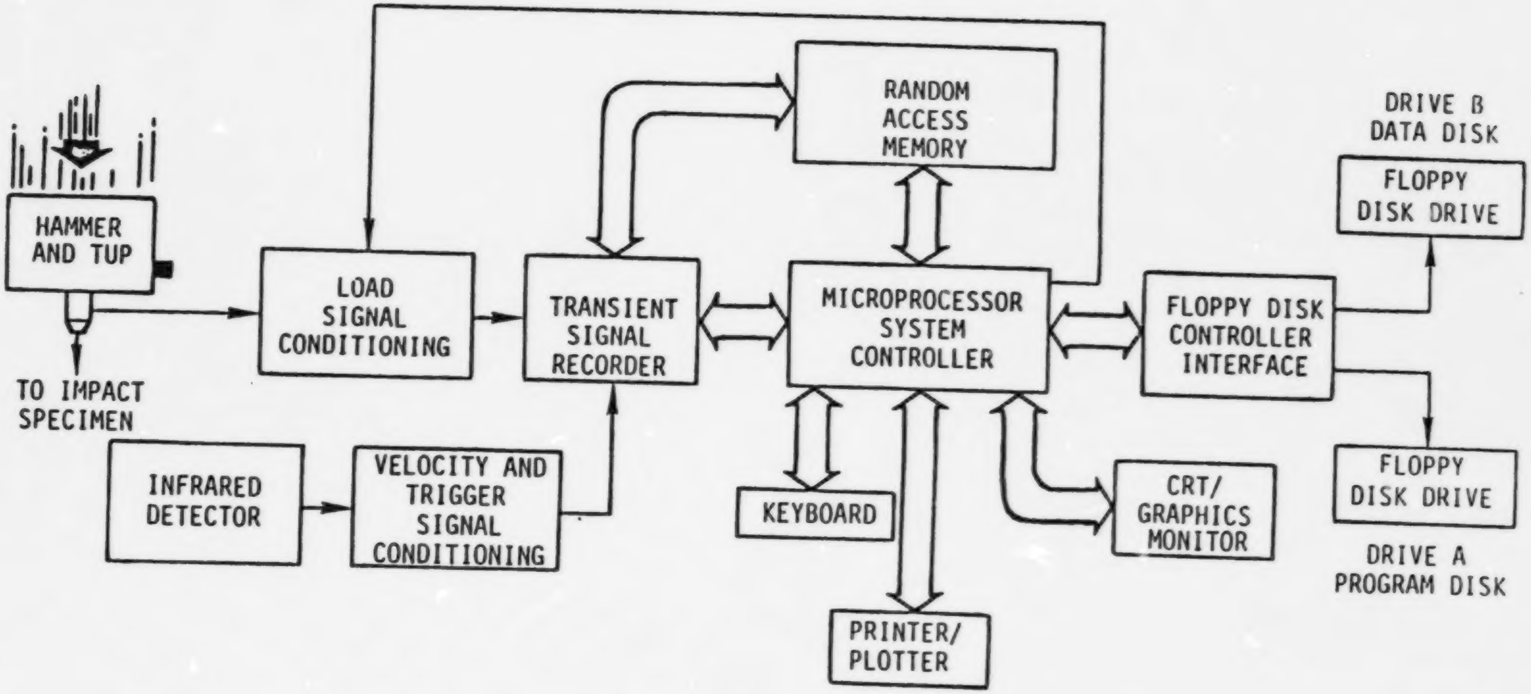

HAMMER AND TUP
TO IMPACT SPECIMEN
LOAD SIGNAL CONDITIONING
TRANSIENT SIGNAL RECORDER
RANDOM ACCESS MEMORY
MICROPROCESSOR SYSTEM CONTROLLER
FLOPPY DISK CONTROLLER INTERFACE
DRIVE B DATA DISK
FLOPPY DISK DRIVE
FLOPPY DISK DRIVE
DRIVE A PROGRAM DISK
INFRARED DETECTOR
VELOCITY AND TRIGGER SIGNAL CONDITIONING
KEYBOARD
PRINTER/ PLOTTER
CRT/ GRAPHICS MONITOR

Figure 2. BLOCK DIAGRAM FOR TYPICAL AUTOMATED INSTRUMENTED IMPACT SYSTEM

TABLE I

OUTPUT PARAMETERS *

ΔE_O	Total energy absorbed during the impact event measured by the system and corrected for instrumentation drift and velocity decrease of the tup during the event, foot-pounds.
ΔE_I	Energy absorbed to fracture initiation (i.e., maximum load) measured by the system and corrected for instrumentation drift and velocity decrease of the tup during the event, foot-pounds.
ΔE_F	Energy absorbed to fracture measured by the system and corrected for instrumentation drift and velocity decrease of the tup during the event, foot-pounds. This value will be the same as ΔE_I if fracture occurs at maximum load.
ΔE_{GY}	Energy absorbed to general yield measured by the system and corrected for instrumentation drift and velocity decrease of the tup during the event, foot-pounds.
ΔE_{FL}	Energy absorbed to the flow load measured by the system and corrected for instrumentation drift and velocity decrease of the tup during the event, foot-pounds.
ΔE_P	Energy absorbed during crack propagation, foot-pounds $= \Delta E_O - \Delta E_I$.
ΔE_S	Energy to form shear lips $= \Delta E_O - \Delta E_F$. Applicable to specimens showing ductile initiation and crack arrest, foot-pounds.
P_{GY}	Load to general yield, pounds.
P_M	Maximum load, pounds.
P_F	Load to fracture, pounds.
P_A	Load to crack arrest, pounds.

---

* All output parameters must be expressible in both ENGLISH and METRIC units.

ΔP	Load decrease during crack propagation, pounds, $= P_F - P_A$.
t_{GY}	Time to general yield, msec.
t_M	Time to maximum load, msec.
t_f	Time to completion of the impact event, msec.
t_Δ	Time to fracture, msec.
t_{FL}	Time to flow load, msec.
P_{FL}	Flow load $P_{FL} = (P_{GY} + P_M)/2$, pounds.
σ_Y	Dynamic yield strength, psi $\sigma_Y = 2.85\ P_{GY}/b^2$ (Reference 1 - Equation 5).
σ_{FL}	Dynamic flow strength, psi, $\sigma_{FL} = 2.85\ P_{FL}/b^2$ (Reference 1 - Equation 5).
E_M	True specimen energy, foot-pounds.

a. For linear-elastic fracture $E_M = \dfrac{C_{ND}(P_M^2)}{2\ BY}$

(Reference 2 - Equation 10)

where Y = Young's Modulus

b. For general yield fracture (cleavage)

(Reference 2 - Equation 11)

$$E_M = \Delta E_I - \{(P_M^2/2)\ [C_T - (C_{ND}/YB)]\}$$

where $C_T = (V_o\ t_{GY}/P_{GY}) - (V_o^2\ t_{GY}^2/8E_o)$

(Reference 2 - Equation 12)

c. For general yield fracture (shear)

$$E_M = \Delta E_{FL} - \{(P_{FL}^2/2)\ [C_T - (C_{ND}/YB)]\}$$

(Reference 2 - Equation 11).

J_{Ic}	Ductile fracture toughness, inch-pound/inches^2 $J_{Ic} = 2E_M/Bb$ (Reference 2 - Equation 16)
K_{Jc}	Stress intensity equivalency, Ksi $\sqrt{in}$ $K_{Jc} = (YJ_{Ic})^{1/2}$ (Reference 2 - Equation 17)
K_{PCI}	Linear-elastic fracture toughness, Ksi $\sqrt{in}$ (Reference 3 - Section A3.5.3) $K_{PCI} = (P_M S/BW^{3/2})\ f\ (a/W)$ where: $f(a/W) = \frac{3(a/W)^{1/2}\ [1.99 - (a/W)\ (1-a/W) \times (2.15 - 3.93\ a/w + 2.7\ a^2/w^2)]}{2\ (1 + 2\ a/W)\ (1-a/W)^{3/2}}$
$\dot{K}$	Stress intensification rate, Ksi $\sqrt{in}$ / sec. (Reference 3 - Section 9.4) a. Before general yield $\dot{K} = K_{PCI} / t_m$ b. After general yield $\dot{K} = K_{PCI} / t_f$

TABLE II

OPERATOR SUPPLIED INPUT PARAMETERS *

1. Test Title
2. Test Date
3. Specimen Identity
4. Specimen material and condition
5. Test Temperature
6. Initial Velocity, V_o
7. Total Available Energy, E_o
8. Nondimensional Specimen Compliance, C_{ND}
9. Tup Calibration Factor
10. System Response and Filtering Factor Inputs
11. Test Operator
12. Specimen Dimensions
    a. Thickness, Inches, B
    b. Width, Inches, W
    c. Average Initial Crack Length, Inches, a
    d. Remaining Ligament, Inches, b

---

* All input parameters must be expressible in both ENGLISH and METRIC units.

3. SYSTEM CHECKOUT AND CALIBRATION

3. SYSTEM CHECKOUT AND CALIBRATION

SYSTEM CHECKOUT AND CALIBRATION

Satisfactory operation and performance of the system shall be demonstrated by separate and composite tests of the various subsystems. These tests can be identified to the subsystems as follows:

1. Impact Machine
2. Instrumentation
    a. Velocity
    b. Tups
    c. Data Processing

The required performance tests for each are discussed below. Seller is encouraged to suggest additional and/or alternative acceptance tests.

IMPACT MACHINE

All control functions for operation of crosshead motion and hammer release must be demonstrated. Of specific importance are the hammer release operation and safety interlock systems. Checks shall be made of the safety interlock system for possible occurrences of abrupt power interruption at each of the various stages of crosshead motion and latch mechanism operation.

The drop height indicator system shall be demonstrated for operational changes of specimen size (i.e., the impact point) and various hammer release heights from approximately 150 mm through full capacity in incremental changes of approximately 300 mm. These checks of height indicator operation can be coordinated with those for the velocity measurement and shock absorbing systems.

It is imperative that adequate clearances are maintained between hammer, anvil, tup and bottom base plate. The anvils are not designed to endure a direct impact by the hammer. The tup can be severely damaged when impacted by any other object than a properly prepared test specimen. Special consideration must be given to placement of the anvil span relative to the specimen size. Use of too large a specimen, relative to support span, can result in jamming of the broken specimen pieces between tup and anvil.

The operation of the shock absorbing system shall be checked at a minimum of three drops each from the heights employed for the height indicator system tests. These tests should start at the lower levels and carefully increase only when the shock absorbing system is operating satisfactorily. Test specimens should not be used for these tests. After each drop, carefully inspect all components in the impact area for evidence of abnormal interactions. Also check for evidence of shock induced loosening of bolts/nuts.

INSTRUMENTATION

The various components and subsystems employed for data acquisition analysis and reporting shall be checked for satisfactory operation.

A. VELOCITY

Satisfactory operation of the velocity measuring system can be demonstrated during the drop tests of the shock absorbing system. Theoretical velocity (v) can be calculated from the following expression

$$v = (2gh)^{1/2} ,$$

where g is the gravitational constant and h is the drop height. Measured impact velocity shall agree within ± 2 percent of that computed by the above expression.

The difference between initial and final velocity for a free drop (i.e., no test specimen) shall be demonstrated accountable by the difference in target spacing. The resultant computation of energy by velocity measurements shall be demonstrated to satisfactorily compensate for the change in hammer potential energy during the time between first and second target time measurements.

B. TUPS

The output from the tups must be shown to be linear, within ± 3 percent of value, with applied load over the range from 10 to 90 percent of rated value. The specific gain factor for each tup must be referenced to the data processing apparatus. For example, a kN force per output volts value which is operator input to the microprocessor system processing the data.

Satisfactory operation of the tups and attendant data processing apparatus shall be demonstrated by tests on typical test specimens. These specimens shall be of the dynamic tear design and cover the range of expected specimen thicknesses between 20 and 50 mm. When the specimen is broken, the total absorbed energy is obtained from two independent sources. The first is the primary reference value and is that processed from the velocity measurements before and after impact fracture of the specimen. The second is that which results from processing the load-time data generated by the tup. These two values of specimen absorbed energy should agree within ± 3 percent. A minimum of ten tests shall be performed for each of the tups.

C. DATA PROCESSING

Satisfactory operation of the data processing and reporting apparatus shall be demonstrated by comparisons of manual calculations with that generated by the software system. These comparisons shall be demonstrated for each of the tests performed to check the tup operation.

Acceptable performance of the Data Processing shall be the sole judgment of CANMET.

4. DETAILED ENGINEERING DRAWINGS OF STRUCTURAL AND MECHANICAL SYSTEMS, WITH DISCUSSION

COMMENTARY ON DW'G. 3001 DROP TOWER CONSOLE

The console (DW'G. 3001) contains all power lines and controls necessary for operating the impact machine. The console controls are the following:

1 On-Off POWER switch (115VAC 60 HERTZ)

2 On-Off POWER light indicator

3_1 (F/C ENGAGE - LEFT) This light goes on when the (Left) Frame/Crosshead air cylinder front end rod is fully extended to lock the Frame and Crosshead together. The light goes off as soon as the rod begins to retract.

3_2 (F/C ENGAGE - RIGHT) This light goes on when the (Right) Frame/Crosshead air cylinder front end rod is fully extended to lock the Frame and Crosshead together. The light goes off as soon as the rod begins to retract.

3_3 (F/C DISENGAGE - LEFT) This light goes on when the (Left) Frame/Crosshead air cylinder front end rod is fully retracted. The light goes off as soon as the rod begins to extend.

3_4 (F/C DISENGAGE - RIGHT) This light goes on when the (Right) Frame/ Crosshead air cylinder front end rod is fully retracted. The light goes off as soon as the rod begins to extend.

3_5 (C/H ENGAGE - LEFT) This light goes on when the (Left) Crosshead/Hammer air cylinder front end rod is fully extended to lock the Crosshead and Hammer (drop weight) together. The light goes off as soon as the rod begins to retract.

3_6 (C/H ENGAGE - RIGHT) This light goes on when the (Right) Crosshead/Hammer air cylinder front end rod is fully extended to lock the Crosshead and Hammer (drop weight) together. The light goes off as soon as the rod begins to retract.

3_7 (C/H DISENGAGE - LEFT) This light goes on when the (Left) Crosshead/ Hammer air cylinder front end rod is fully retracted. The light goes off as soon as the rod begins to extend.

3_8 (C/H DISENGAGE - RIGHT) This light goes on when the (Right) Crosshead/ Hammer air cylinder front end rod is fully retracted. The light goes off as soon as the rod begins to extend.

3_9 (L/T RELEASE) This light goes on when the Latch Trip air cylinder is fully retracted. Note that when the Latch Trip air cylinder is fully retracted, the hammer has been released. The light goes off as soon as the rod begins to extend.

3_{10} (L/T RE-ENGAGE) This light goes on when the Latch Trip air cylinder is fully extended. Note that when the Latch Trip air cylinder is fully extended, the hammer has been re-engaged. The light goes off as soon as the rod begins to retract.

4 (SAFE) This light goes on only when all of the following are true:
  a) the Latch Trip air cylinder is fully extended
  b) the (Left) Crosshead/Hammer air cylinder is fully extended
  c) the (Right) Crosshead/ Hammer air cylinder is fully extended
  d) the (Left) Frame/Crosshead air cylinder is fully extended
  e) the (Right) Frame/Crosshead air cylinder is fully extended
If any of the above are not true, the light will be off.

5_1 (LOWER LIMITED ENGAGED) This light goes on when the crosshead reaches the bottom of its permitted travel at which point the Duff-Norton SK-6000 -C-40 rotary limit switch which is connected to one of the Duff-Norton Jactuator units is tripped, preventing further advance up or down.

5_2 (UPPER LIMIT ENGAGED) This light goes on when the crosshead reaches the top of its permitted travel at which point the Duff-Norton SK-6000-C-40 rotary limit switch is tripped, preventing further advance up or down. The upper limit should be set so that when tripped, the Frame and Crosshead are correctly aligned for engagement by the Frame/Crosshead air cylinders.

5_3 (CAUTION) This light goes on when all of the following are true:
  a) the (Left) Crosshead/Hammer air cylinder front end rod is in any position but fully extended
  b) the (Right) Crosshead/Hammer air cylinder front end rod is in any position but fully extended
  c) control relay 1-CR is depowered - see 1-CR description
If any of the above are not true, then the light will be off.

6 (SIREN) This siren goes on when all the following are true:
  a) the (Left) Crosshead/Hammer air cylinder front end rod is in any position but fully extended
  b) the (Right) Crosshead/Hammer air cylinder front end rod is in any position but fully extended
  c) control relay 1-CR is depowered - see 1-CR description
  d) console button 10_2 is not pushed in
If any of the above are not true, then the siren will be off.

7_1 (F/C ENGAGE) This is a momentary contact push button. When pressed and released it extends the front end rods of the Left and Right Frame/Crosshead air cylinders. This locks the Frame and Crosshead together.

7_2 (F/C DISENGAGE) This is a momentary contact push button. When pressed and released it retracts the front end rods of the Left and Right Frame/Crosshead air cylinders. This releases the Frame from the Crosshead.

7_3 (C/H ENGAGE) This is a momentary contact push button. When pressed and released it extends the front end rods of the Left and Right Crosshead/Hammer air cylinders. This locks the Crosshead and Hammer together.

7_4 (C/H DISENGAGE) This is a momentary contact push button. When pressed and released it retracts the front end rods of the Left and Right Crosshead/Hammer air cylinders. This releases the Crosshead from the Hammer.

7_5 (L/T RELEASE) This is a momentary contact push button. When pressed and released it releases the Hammer by retracting the Latch Trip air cylinder rod.

7_6 (L/T RE-ENGAGE) This is a momentary contact push button. When pressed and released it re-engages the Hammer to the crosshead by extending the Latch Trip air cylinder rod.

8_1 (MAIN MOTOR STOP) This is a momentary contact push button. When pressed (and released) it depowers the main Crosshead drive motor.

8_2 (MICRO MOTOR STOP) This is a momentary contact push button. When pressed (and released) it depowers the microspeed Crosshead drive motor.

9_1 (MAIN MOTOR UP) This is a momentary contact push button. When pressed (and released) it moves the crosshead up at main motor speed. The Crosshead will continue moving up until the upper limit is tripped, or another motor control button is pushed.

9_2 (MAIN MOTOR JOG UP) This is a momentary contact push button. When pressed and held down, the Crosshead moves up at main motor speed. When the button is released, the Crosshead stops.

9_3 (MAIN MOTOR DOWN) This is a momentary contact push button. When pressed (and released) it moves the crosshead down at main motor speed. The Crosshead will continue moving down until the lower limit is tripped, or another motor control button is pushed.

9_4 (MAIN MOTOR JOG DOWN) This is a momentary contact push button. When pressed and held down, the Crosshead moves down at main motor speed. When the button is released, the Crosshead stops.

9_5 (MICROSPEED MOTOR UP) This is a momentary contact push button. When pressed (and released) it moves the crosshead up at micro motor speed. The Crosshead will continue moving up until the upper limit is tripped, or another motor control button is pushed.

9_6 (MICROSPEED MOTOR JOG UP) This is a momentary contact push button. When pressed and held down, the Crosshead moves up at microspeed motor speed. When the button is released, the Crosshead stops.

9_7 (MICROSPEED MOTOR DOWN) This is a momentary contact push button. When pressed (and released), it moves the Crosshead down at microspeed motor speed. The Crosshead will continue moving down until the lower limit is tripped, or another motor control button is pushed.

9_8 (MICROSPEED MOTOR JOG DOWN) This is a momentary contact push button. When pressed and held down, the Crosshead moves down at microspeed motor speed. When the button is released, the Crosshead stops.

10_1 (LIMITS OVERRIDE) This is a momentary contact push button. When pressed and held down it provides control power to the Crosshead motors by bypassing the automatic safety relays of the Crosshead/Hammer and Frame/Crosshead air cylinders. It also bypasses the D-N rotary limit switch. Whenever either of the Crosshead drive limits are tripped, this button must be held down while the operator jogs at micromotor speed away from the tripped position.

10_2 (SIREN OFF) This is a momentary contact push button. When pressed and held down it will either stop the siren or prevent it from going on.

11 (CROSSHEAD POSITION, ABSOLUTE) This console gauge is a DUFF-NORTON SK-6300 Visual Position Indicator. It consists of a graduated meter and a calibration box. The meter is calibrated in percent of travel from zero to 100. Both meter and box are console mounted. When calibrated correctly, when the lower limit of the Crosshead drive is tripped, then the meter will read zero percent; when the upper limit of the Crosshead drive is tripped, then the meter will read one hundred percent. This gauge tells the operator the absolute position of the Crosshead relative to the upper and lower limits.

12 (CROSSHEAD POSITION, FLOATING) Like ⑪, this is a self-contained passive transducer system. It consists of a Q-M Model 1110 chrome on glass scale transducer located on tower frame and Crosshead. This transducer signals a Q-M Model 4051 EMP digital readout located in the console. The full floating zero of the LED display allows the convenience of establishing a zero reference point at the top of any drop tower specimen, irregardless of its height or the height of the TUP assembly.

The following explains the 4051 EMP controls. In the following note that the ERROR INDICATOR light is shown as ON in DWG 3001. It is the LED dot to the left of -024.6802. Note that the thumb wheel switches on DWG 3001 are shown as -000.0000.

4051 EMP DISPLAY UNIT, CONTROLS AND INDICATORS

Control/Indicator	Use
Digital Display	Indicates, in direct readout, the dimension being measured by the instrument connected to the unit. Sign (+ or -) indicates direction of movement from zero reference point; + indicates larger (up or open from zero point) and - indicates smaller (down or closing towards zero point). Decimal point will appear in one of two positions; the decimal point switches towards the right one position when metric (MM) display is selected. The number of numerals following the decimal point will be 2, 3, or 4, depending on the measurement mode selected: • If MM/IN switch is in MM position 2 or 3 digits are displayed following the decimal point, depending on the resolution of the system in use. • If MM/IN switch is in IN position, 4 digits are displayed. NOTE: The error indicator on the display will light and the display reading will remain unchanged if the instrument movement is faster than the system can measure accurately. If this happens, simply press the RESET switch and repeat the measurement.
RESET Switch	When pressed, sets display and counting circuits to zero.
MM/IN Switch	Selects the English or metric measurement mode of operation. In the MM position, display shows the measurement in millimeters, to 2 or 3 decimal places. When in the IN position, display shows measurement to 4 decimal places.
LOAD Switch	Used in conjunction with Thumbwheel switches to preset display and counting circuits to a desired value. When pressed down, value selected on Thumbwheel switches is loaded into counting circuits and displayed.
Thumbwheel Switches	Individual switches allow presetting of desired value into the display and counting circuits. Used in conjunction with the LOAD Switch.
SAVE/RECALL Switch (DUAL DATUM MEMORY)	This three position switch is used with the dual datum memory option to store and read information from memory.

4051 EMP DISPLAY UNIT, CONTROLS AND INDICATORS (con't)

Control/Indicator	Use
	• SAVE position loads the memory with whatever value is shown on the display. This value becomes the starting point for additional measurements. • Center (spring-loaded) position of the switch allows the value stored in memory to be increased or decreased as the measuring instrument is moved. • RECALL position recalls the stored information from memory and shows it on the display. NOTE: Information will be stored in memory in terms of either inches or millimeter measurements. The data must be recalled in the same mode it was stored in. Attempting to recall millimeter data in inches, for example, will result in erroneous readings on the display.

It is recommended that the fabricator give consideration to the following when detailing the DROP TOWER CONSOLE assembly:

- free standing moveable weldment assembly
- fabricate from 12 ga. or lighter mild steel sheet
- sand blast and paint as per GUERTIN BROS. (Winnipeg, Man.) Aluminum Moisture Cure urethane base primer CODE SP 3541 UPC-6-001 with Aliphatic polyester polyurethane finish coat CODE UTC-2, colour as per CANMET'S preference.*
- console control panel face should be located in a rotated up from horizontal position (approx. 30°).
- layout console height to be suitable for the 50th percentile, Medium standing man as indicated in SAE J 833(JAN 80) USA HUMAN PHYSICAL DIMENSIONS
- use full area transparent GE LEXAN type material on console face with drop tower console control descriptions painted on underside
- locate console within 25 feet horizontally of drop tower
- locate motor starters for MANNESMAN DEMAG Crosshead Drive main motor and microspeed motor in console (see DWG. 3002)
  - Starting time for the micro motor is comparable to the transfer time on the main motor. To ensure a soft transition one can energize the micro motor at the same time as the current is cut to the main motor.
  - Use Siemens size II reversible contactors for the main motor and size I for the micro motor. Alternatively any other make may be used, such as ALLEN-BRADLEY Bulletin 705 full voltage magnetic reversing starters. The Siemens units are preferred by MANNESMANN DEMAG. Mr. Zsolt Villanyi, Drives Specialist, 2400 Royal Windsor Drive, Mississauga, Ontario, L5J 1K7 (416) 823-4500 can be contacted for specific quotations.
- locate motor(s) jogging relays in console
  - for 3-CR → 10-CR inclusive, use ALLEN-BRADLEY Bulletin 700 or similar
- locate balance of control relays in console
  - for 1-CR, 2-CR, 11-CR → 21-CR inclusive, use POTTER & BRUMFIELD hermetically sealed KRP14AG, 120V, 3PDT or similar

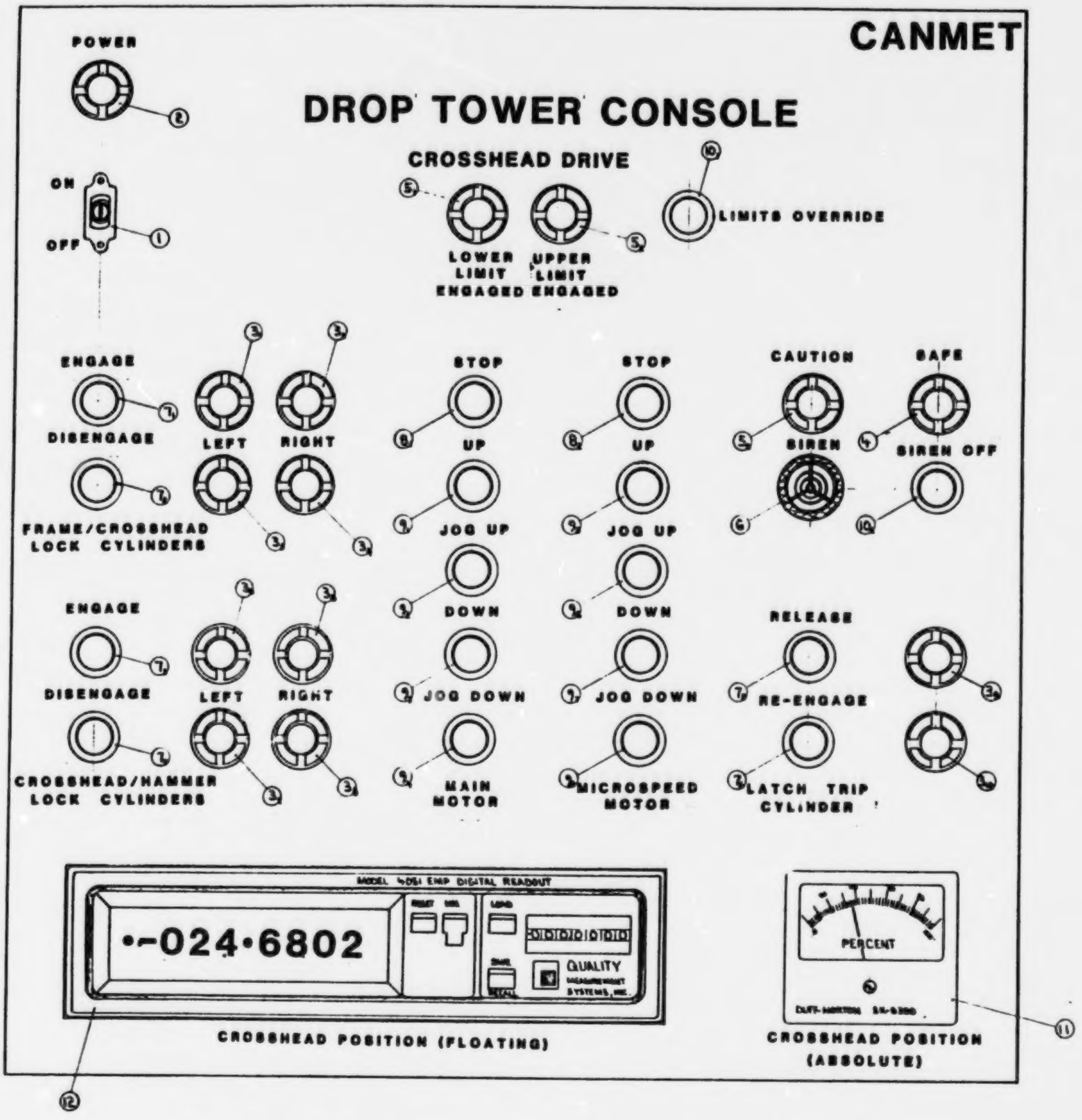
---

* Note that we recommend the same exterior finish for all tower assembly weldments.

. console to meet CSA Enclosure 3 standards or better

. conductor sizing, wiring methods as per

  - C22.1 - 1978 Canadian Electrical Code, Part 1, Safety Standards for Electrical Installations
  - C22.2 No. 73-1953 (R1965) Electrically Equipped Machine Tools


CANMET
DROP TOWER CONSOLE
POWER
ON
OFF
CROSSHEAD DRIVE
LOWER LIMIT ENGAGED
UPPER LIMIT ENGAGED
LIMITS OVERRIDE
ENGAGE
DISENGAGE
FRAME/CROSSHEAD LOCK CYLINDERS
LEFT
RIGHT
STOP
UP
JOG UP
DOWN
JOG DOWN
MAIN MOTOR
MICROSPEED MOTOR
CAUTION
SAFE
SIREN
SIREN OFF
RELEASE
RE-ENGAGE
LATCH TRIP CYLINDER
ENGAGE
DISENGAGE
CROSSHEAD/HAMMER LOCK CYLINDERS
MODEL 405I EMP DIGITAL READOUT
•-024•6802
RESET
QUALITY MEASUREMENT SYSTEMS, INC.
CROSSHEAD POSITION (FLOATING)
PERCENT
CROSSHEAD POSITION (ABSOLUTE)
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
1	12	3012	60 HZ, PANEL MOUNT DICATOR (FLOATING), 115 VAC, CROSSHEAD VISUAL POSITION IN-	ON GLASS TRANSDUCER CONJUNCTION WITH QMS MODEL 1110 CHROME MODEL 4051 EMP DIGITAL READOUT, USED IN QMS (QUALITY MEASUREMENT SYSTEMS CORP.)
1	11	3011	CALIBRATION BOX, PANEL MOUNT 60 HZ, GRADUATED METER WITH DICATOR (ABSOLUTE), 115 VAC, CROSSHEAD VISUAL POSITION IN-	NO. SK-6000-C-40 LIMIT SWITCH TRANSDUCER MOUNTED ON END OF DUFF-NORTON WITH DUFF-NORTON NO. SK-6200-T POSITION DUFF-NORTON NO. SK-6300 IN CONJUNCTION
2	10	3010	HEAD, BLACK PANEL MOUNT 1 N-C, 115 VAC, 60 HZ, FLUSH SADDLE CLAMP TERMINAL, 1 N-O/ MOMENTARY CONTACT PUSH BUTTON,	ALLEN BRADLEY NO. 800H-AP2A
8	9	3009	HEAD, GREEN PANEL MOUNT 3 N-C, 115 VAC, 60 HZ, FLUSH SADDLE CLAMP TERMINAL, 3 N-O/ MOMENTARY CONTACT PUSH BUTTON	ALLEN BRADLEY NO. 800H-AP1H
2	8	3008	HEAD, RED PANEL MOUNT 3 N-C 115 VAC, 60 HZ, MUSHROOM SADDLE CLAMP TERMINAL 3 N-O/ MOMENTARY CONTACT PUSH BUTTON	ALLEN BRADLEY NO. 800H-DP6H
6	7	3007	HEAD, YELLOW PANEL MOUNT 2 N-C, 115 VAC, 60 HZ, FLUSH SADDLE CLAMP TERMINAL, 2 N-O/ MOMENTARY CONTACT PUSH BUTTON	ALLEN BRADLEY NO. 800H-AP9B
1	6	3006	PANEL MOUNT PULSE AT 1.5 PULSES PER SECOND, PRESSURE AT TWO FEET, SLOW VAC, 60 HZ, 95dB(A) SOUND INTERMITTENT TONE BUZZER, 115	MALLORY NO. SC110NJ
3	5	3005	MINAL, PANEL MOUNT VAC, 60 HZ, SADDLE CLAMP TER- FLASHING PILOT LIGHT, RED, 115	ALLEN BRADLEY NO. 800H-PPF16R
1	4	3004	PANEL MOUNT 60 HZ, SADDLE CLAMP TERMINAL, PILOT LIGHT, GREEN, 115 VAC,	N104G COLOR CAP ASSEMBLY ALLEN BRADLEY NO. 800H-PP16 PLUS 800H-
10	3	3003	PANEL MOUNT 60 HZ, SADDLE CLAMP TERMINAL, PILOT LIGHT, AMBER, 115 VAC,	N104A COLOR CAP ASSEMBLY ALLEN BRADLEY NO. 800H-PP16 PLUS 800H-
1	2	3002	PANEL MOUNT 60 HZ, SADDLE CLAMP TERMINAL, PILOT LIGHT, BLUE, 115 VAC,	N104B COLOR CAP ASSEMBLY ALLEN BRADLEY NO. 800H-PP16 PLUS 800H-
1	1	3001	ON-OFF, S.P.S.T., PANEL MOUNT LONG BAT HANDLE, 2 POSITION - TOGGLE SWITCH, CHROME PLATED, EXTRA HEAVY DUTY DIE CAST	COLE HERSEE NO. 551840

LIST OF MATERIAL

TOLERANCES ON

1 PLACE DEC.	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .010 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .010-.020.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON, SASKATCHEWAN

TITLE
DROP TOWER CONSOLE

DRAWN
APRIL 14, 1983 MALINOSKI

CHECKED

SCALE HALF

DRAWING NO.
3001

REV

WEIGHT

OF

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

CROSS REFERENCE — DWG. 3002 —
CONTROL SCHEMATIC - DROP
TOWER CONSOLE

COMMENTARY ON DWG 3002 CONTROL SCHEMATIC - DROP TOWER CONSOLE

This control arrangement makes use of conventional relays, and associated hardware. For this application we feel this design is sufficient for the least expense. Note that programmable control is also available if a more sophisticated easily upgradeable control system is desired. An example of one of the many small state-of-the-art programmable controllers available is SQUARE D's SY/MAX Model 100 which has been used in applications to replace as few as 5 relays.

CONTROL RELAYS

1 - CR with 1 - CR - A (N-O) (line positions 48,46,45)
1 - CR - B (N-C)
1 - CR - C (N-C)

These are part of the siren circuit. When the (Left) Crosshead/Hammer air
cylinder is fully extended and therefore in the engaged position, its front
end S.P.D.T. limit switch is activated. Thus the N-O is closed, the N-C is
(48,44, 46,45) open. No power is available for 1-CR, 16-CR, 6 siren, or 5_3 caution light.
(43) However, console light 3_5 is on.

As soon as the C/H (left) cylinder starts to move away from its engaged posi-
tion, the front end S.P.D.T. limit switch returns to its N-C and N-O positions.
(43,44) Console light 3_5 goes off. 16-CR receives power. See 16-CR description for
(45-44, 42) significance of this. Assuming 18 - CR - C is closed, (see 18 - CR description
(45,46) to see when this is so) then 5_3 console caution light starts flashing and 6
(48) siren goes on. 1 - CR still has no power.

With the C/H cylinders retracted, we now release the latch. This requires re-
tracting the latch trip air cylinder. When the latch trip cylinder is fully
(48) retracted, its blind end D.P.D.T. limit switch is activated. Thus 1 - CR now
(48,46, 45) gets power. Therefore, 1 - CR - A closes, 1 - CR - B and 1 - CR - C open,
(46,45) shutting off 6 siren and 5_3 console caution light.

When the latch trip cylinder is extended to close the latch, the blind end
(48) D.P.D.T. limit switch goes back to N-C and N-O. But 1 - CR stays on because
(46,45) 1 - CR - A is closed. So 6 siren and 5_3 console caution light are still off.

When the C/H (left) cylinder is again extended, its front end S.P.D.T. limit
(43) switch is activated such that N-O closes and turns ③$_5$ light on. N-C opens
(44,48, 46) and removes power from 16 - CR and 1 - CR. Thus, 1 - CR - A opens, 1 - CR - B
(46,45) and 1 - CR - C close. But ⑥ siren and ⑤$_3$ console caution light remain off.
However, we have come full circle with the siren and console caution light reset, ready to go off when C/H left cylinder again starts to retract.

Note that C/H (left) and (right) air cylinders are both controlled centrally from a single pneumatic directional control valve. So it is arbitrary that we're using the left cylinder to take prompts from - it could also be the right one.
(45-44, 42) Note the significance of 18 - CR - C. It is closed only when 18 - CR is
(42) powered. 18 - CR is powered only when the C/H (right) cylinder is not fully extended. It assures then that both C/H cylinders must be retracted for the console siren and caution light to work.

(46) Panel button ⑩$_2$ is momentary contact N-C. It is a convenience which allows the panel buzzer to be shut off at any time, but only as long as you keep your finger on the button. Generally, there should be no reason to shut off the buzzer before it goes full cycle and shuts itself off.

Note on DWG 3002 the alternative location reference for the C/H left and right air cylinders front end S.P.D.T. limit switches. That is alternatively using end plunger type limits located on the crosshead such that they are tripped by the rods at the end of their stroke. The advantage in using the limits in this way is that it becomes impossible to fool the control console. This is so because now the only way to actuate these limits is when the crosshead and hammer are in the lock position. Extending the C/H cylinders in any other position will not activate the limits. On the other hand, it is reasonable to assume that all operators will be conscientious and would never leave the C/H air cylinders extended unless it was in the lock position of crosshead and hammer.

2 - CR with 2 - CR - A (N-C) (line positions 25,13)

(25,13) When 2 - CR is powered, 2 - CR - A is open which prevents both cross-
head motors from working. This happens when the (left) Frame/Crosshead air
cylinder is in any position but fully retracted. When the cylinder is fully
(24) retracted, its back end S.P.D.T. limit switch is activated. Then 3_3 panel
(25,13) light goes on. 2 - CR is depowered. 2 - CR - A closes.

11 - CR with 11 - CR - A (N-C) (line positions 23,13)

(23,13) When 11 - CR is powered, 11- CR - A is open which prevents both cross-
head motors from working. This happens when the (right) Frame/Crosshead air
cylinder is in any position but fully retracted. When the cylinder is fully
(22) retracted, its back end S.P.D.T. limit switch is activated. Then 3_4 panel light
(23,13) goes on. 11 - CR is depowered. 11 - CR - A closes.

3 - CR with	3 - CR - A (N-O)	(7,70)	
	3 - CR - B (N-O)	(69)	
	3 - CR - C (N-O)	(68)	
	3 - CR - D (N-C)	(2)	
4 - CR with	4 - CR - A (N-O)	(6,7-6)	main crosshead motor control
	4 - CR - B (N-O)	(5)	
5 - CR with	5 - CR - A (N-O)	(4,3)	
	5 - CR - B (N-O)	(3-2)	
6 - CR with	6 - CR - A (N-O)	(2,67)	
	6 - CR - B (N-O)	(66)	
	6 - CR - C (N-O)	(65)	
	6 - CR - D (N-C)	(7)	
7 - CR with	7 - CR - A (N-O)	(13,64)	
	7 - CR - B (N-O)	(63)	
	7 - CR - C (N-O)	(62)	
	7 - CR - D (N-C)	(8)	
8 - CR with	8 - CR - A (N-O)	(12,13-12)	
	8 - CR - B (N-O)	(11)	micromotor crosshead motor control
9 - CR with	9 - CR - A (N-O)	(10,9)	
	9 - CR - B (N-O)	(9-8)	
10- CR with	10 - CR - A (N-O)	(8,61)	
	10 - CR - B (N-O)	(60)	
	10 - CR - C (N-O)	(59)	
	10 - CR - D (N-C)	(13)	

Regarding 3 - CR + 10 - CR in this arrangement for jogging and running in either direction "jogging relays" are used to insure safe jogging. These relays prevent either the forward or reverse contactor from locking in during jogging.

Note the use of 1 N-O/2 N-C momentary contact push buttons to ensure that only one motor can be operating at one time. Allen-Bradley Bulletin 800 H heavy duty push buttons are recommended, see DWG 3001. It is convenient to use the 3 N-O/3 N-C and wire them as 1 N-O/2 N-C.

12-CR with 12-CR-A (N-O) (38,54)
12-CR-B (N-O) (53)

13-CR with 13-CR-A (N-O) (35,54)
13-CR-B (N-O) (53)

When the (left) Crosshead/Hammer air cylinder is fully retracted, then
(38,54, 53) 12-CR is powered. Then contacts 12-CR-A and 12-CR-B are closed. When
(35) the (Right) Crosshead/Hammer air cylinder is fully retracted, then 13-CR
(54,53) is powered. Then contacts 13-CR-A and 13-CR-B are closed. Also console
(39,36) lights 3_7 and 3_8 are on. Now the latch trip cylinder can be operated.
If the C/H cylinders are not fully retracted, then the latch trip cylinder
cannot be operated.

(38) As soon as C/H (Left) and C/H (Right) cylinders begin to extend, 12-CR
(35,54, 53) and 13-CR are depowered. Then 12-CR-A, 12-CR-B, 13-CR-A, and 13-CR-B
are open.

14-CR with 14-CR-A (N-C) (52,13)
14-CR-B (N-C) (30)

(52) When the latch trip cylinder is fully extended, 14-CR is depowered. There-
fore in the console motor control circuit and safe light circuit, contacts
(13,30, 51) 14-CR-A and 14-CR-B are closed. Also console light 3_{10} is on.
(52) As soon as the latch trip cylinder begins to retract, 14-CR receives
(13,30) power. Then 14-CR-A and 14-CR-B are open.

15-CR with 15-CR-A (N-C) (50,10)

(50) When the latch trip cylinder is fully retracted, 15-CR is depowered.
(10) Therefore in the motor control circuit, contact 15-CR-A is closed. Also
(49) console light 3_9 is on.
(50) As soon as the latch trip cylinder begin to extend 15-CR receives power.
(10) Then 15-CR-A is open.

16-CR with 16-CR-A (N-C) (44,13)
16-CR-B (N-C) (30)

(44) When the (Left) Crosshead/Hammer air cylinder is fully extended, 16-CR
(13) is depowered. Therefore contact 16-CR-A in the motor control circuit is
(30) closed, and contact 16-CR-B in the console safe light circuit is closed.
(44) As soon as the C/H (left) cylinder begins to retract, 16-CR is powered.
(13,30) Then 16-CR-A and 16-CR-B are open.

17-CR with 17-CR-A (N-C) (40,10)

(40) When the (left) Crosshead/Hammer air cylinder is fully retracted, 17-CR
(10) is depowered. Then contact 17-CR-A in the motor control circuit is
closed.
(40) As soon as the C/H (left) cylinder begins to extend, 17-CR is powered,
(10) and 17-CR-A is open.

18-CR with 18-CR-A (N-C) (42,13)
18-CR-B (N-C) (30)
18-CR-C (N-O) (45-44)

(42) When the (Right) Crosshead/Hammer air cylinder is fully extended, 18-CR
(41,13) is depowered. Console light 3_6 comes on. Then contact 18-CR-A in the
(30) motor control circuit is closed. Contact 18-CR-B in the panel safe light
(45-44) circuit is closed. Contact 18-CR-C in the panel caution light circuit
is open.
(42) As soon as the C/H (right) cylinder begins to retract, 18-CR is powered,
(13,30, 45-44) and 18-CR-A is open, 18-CR-B is open, 18-CR-C is closed. Console light
(41) 3_6 goes off.

19-CR with 19-CR-A (N-C) (37,10)

(37) When the (Right) Crosshead/Hammer air cylinder is fully retracted, 19-CR
(10) is depowered. Then contact 19-CR-A in the motor control circuit is
closed.

(37) As soon as the C/H (right) cylinder begins to extend, 19-CR gets power,
(10) and 19-CR-A is open.

20-CR with 20-CR-A (N-O) (28,31)

(28) When the (Left) Frame/Crosshead air cylinder is fully extended, 20-CR
(31) gets power. Then contact 20-CR-A in the panel safe light circuit is
(29) closed. Also console light 3_1 is on.

(28) As soon as F/C (left) cylinder starts to retract, 20-CR is depowered.
(31,29) Then 20-CR-A is open. Console light 3_1 is off.

21-CR with 21-CR-A (N-O) (26,30)

(26) When the (Right) Frame/Crosshead air cylinder is fully extended, 21-CR
(30) gets power. Then contact 21-CR-A in the panel safe light circuit is
(27) closed. Also console light 3_2 is on.

(26) As soon as F/C (right) cylinder starts to retract, 21-CR is depowered.
(30,27) Then 21-CR-A is open. Console light 3_2 is off.

(21-18, 34-31) Note the panel push button arrangement with 7_1 and 7_2 or 7_3 and 7_4
(56-53) or 7_5 and 7_6. This is a push buttom interlocking arrangement to prevent
(19-18) energizing both solenoids at the same time. For example, if 7_1 had already
been pressed and was being held, and the action was in progress and then
(21-20) if 7_2 should accidentally be pressed also, current would be removed from
both solenoids. If both buttons were pressed at exactly the same time,
neither valve solenoid would be energized.

(30) Note that the panel safe light ④ is only on when contacts 14-CR-B,
(30) 16-CR-B, 18-CR-B, 20-CR-A, and 21-CR-A are all closed.

(16-13) Note that power to the motor control circuit comes through the D-N SK-6000-C-40 rotary limit switch only as long as the crosshead is in between top and bottom of travel.

(17,7) When at top of travel, panel light 5_2 comes on. Panel button 10_1 must be held down while any of the motors down buttons are pressed. Preferably this should be the microspeed motor JOG DOWN panel button.

(14) When at the bottom of travel, panel light 5_1 comes on. Panel button
(7) 10_1 must be held down while any of the motors up buttons are pressed.
Preferably this should be the microspeed motor JOG UP panel button.

(7) Panel button 10_1 may be used at any time to bypass the safety features of
the automatic stops built in by the relay contacts receiving power from the
(16-13) D-N SK-6000-C-40 rotary limit switch. This should only be done by an
operator who fully understands the implication of his action.

(6-4) Console button 1 is On-Off for all functions on the console.

MOTOR CONTROL CIRCUIT

1. When the Frame/Crosshead air cylinders are fully retracted, both crosshead drive motors will work. If they are not fully retracted, the motors will not work.

   How Done (1)

   Each of the two Frame/Crosshead air cylinders have a backend SPDT limit
   (25,23) switch. When the cylinders are fully retracted, 2-CR and 11-CR
   (13) receive no power ∴ 2-CR-A and 11-CR-A are closed. As soon as the
   (25) cylinders start to move away from the fully retracted position, 2-CR and
   (23,13) 11-CR immediately get power, and 2-CR-A and 11-CR-A open.

2. When the Latch Trip cylinder is extended, and the Crosshead/Hammer cylinders are retracted, both crosshead drive motors will not work.
3. When the Latch Trip cylinder is extended, and the Crosshead/Hammer cylinders are extended (in the lock position), both crosshead drive motors will work.
4. When the Latch Trip cylinder is retracted, and the Crosshead/Hammer cylinders are retracted, both crosshead drive motors will work.
5. When the Latch Trip cylinder is retracted, and the Crosshead/Hammer cylinders are extended (in the lock position), both crosshead drive motors will not work.

   How Done (2., 3., 4., 5.)

   The Latch Trip cylinder rod end has a SPDT limit switch. When the rod
   (52,13) is fully extended, 14-CR receives no power ∴ 14-CR-A is closed.
   (52,13) As soon as the rod begins to retract, 14-CR gets power and 14-CR-A
   opens.

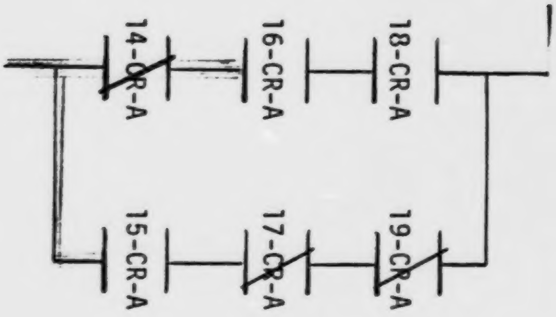
The Latch Trip cylinder blind end has a DPDT limit switch. When the rod
(50,10) is fully retracted, 15-CR receives no power. ∴ 15-CR-A is closed. As
(50,10) soon as the rod begins to extend, 15-CR gets power, and 15-CR-A opens.

The Crosshead/Hammer left and right cylinders have front end SPDT limit
(44,42) switches. When the cylinders are fully extended, 16-CR and 18-CR receive
(13) no power. ∴ 16-CR-A and 18-CR-A are closed. As soon as the rods begin
(44,42,13) to retract, 16-CR and 18-CR get power, and 16-CR-A and 18-CR-A open.

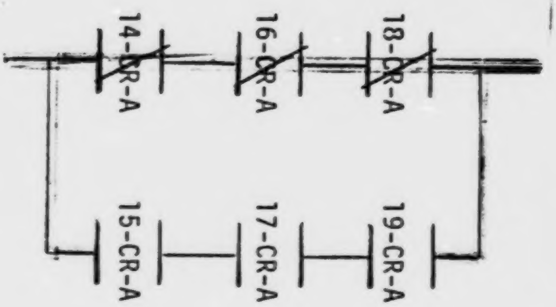
The Crosshead/Hammer left and right cylinders have SPDT limit switches which
are located at the back end of the cylinders assemblies. When the cylinders
(40,37,10) are fully retracted, 17-CR and 19-CR receive no power. ∴ 17-CR-A and
(10,40) 19-CR-A are closed. As soon as the rods begin to extend, 17-CR and
(37,10) 19-CR get power, and 17-CR-A and 19-CR-A open.

MOTOR CONTROL CIRCUIT (continued)

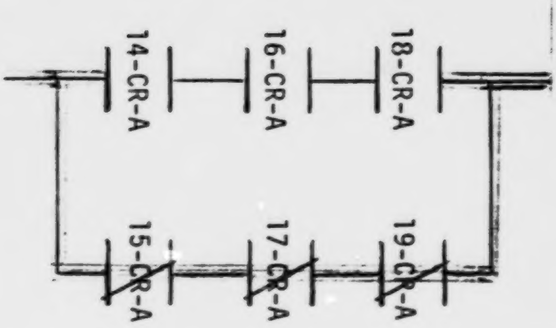
2. Current blocked, both cross-head drive motors will not work.


14-CR-A
16-CR-A
18-CR-A
15-CR-A
17-CR-A
19-CR-A

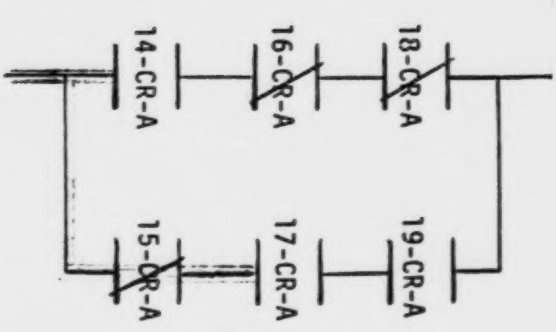
3. Current passes, both cross-head drive motors will work.


14-CR-A
16-CR-A
18-CR-A
15-CR-A
17-CR-A
19-CR-A

4. Current passes, both cross-head drive motors will work.


14-CR-A
16-CR-A
18-CR-A
15-CR-A
17-CR-A
19-CR-A

5. Current blocked, both cross-head drive motors will not work.


14-CR-A
16-CR-A
18-CR-A
15-CR-A
17-CR-A
19-CR-A

The assumption is that an operator will never try to operate the drive motors while a cylinder is moving from one position to another.

RELATIONSHIP BETWEEN CROSSHEAD/HAMMER CYLINDERS AND LATCH TRIP CYLINDER

1. When the Crosshead/Hammer cylinders are retracted, the Latch Trip cylinder can be retracted.
2. When the Crosshead/Hammer cylinders are retracted, the Latch Trip cylinder can be extended.
3. When the Crosshead/Hammer cylinders are in any position other than full retraction, the Latch Trip cylinder cannot be retracted.
4. When the Crosshead/Hammer cylinders are in any position other than full retraction, the Latch Trip cylinder cannot be extended.

How Done (1, 2, 3, 4)

The Crosshead/Hammer left and right cylinders back ends have SPDT
(38) limit switches. When the cylinders are fully retracted, 12-CR and
(35,54,53) 13-CR receive power. Contacts 12-CR-A, 12-CR-B, 13-CR-A, and 13-CR-B
(56-53) then close, allowing control push buttons 7_5 and 7_6 to operate the
latch cylinder solenoids.

Fabricator to prepare a detailed wiring diagram for review by CANMET of Drop Tower Console and related wiring based on schematic concepts of SRC DWG's 3001 and 3002.

CROSSHEAD DRIVE MOTORS

A MANNESMANN DEMAG microspeed drive with DUFF-NORTON jactuators is used to move the crosshead, see DWG. 2001.

The main motor is a KBA 112MA(see page 11 MANNESMAN DEMAG Industrial Drives catalogue 701 IS 900). Page 34 of the catalogue lists available intermediate gear box ratios. Use at least a 10:1 reduction ratio - see calculations that follow. Pages 38 and 39 of the catalogue illustrate micromotor assembly drive dimensions.

Note that the main motor output shaft diameter is 28 mm. It is necessary to connect this shaft to the gear drive through a drive coupling capable of shaft movement under load (see page 4, DEMAG manual). Refer to DEMAG coupling literature for dimensional reference. These couplings satisfy the 'movement' requirement. A 28 mm diameter bore coupling is available.

A HUB CITY metric bevel gear drive was selected with 28 mm input shaft diameter, i.e. 1:1 ratio MODEL NO. 828 (see pages 212, 213 HUB CITY catalogue excerpts). It is more gear box than is needed, but its convenient to use because it eliminates the need for coupling adapters between the main motor and gear box. The extra cost over a MODEL 824 is only $65 U.S. The 1700 RPM input speed has been approved by Mr. Gerry Newharth, Engineering Department, SAFEGUARD AUTOMOTIVE CORPORATION, Aberdeen, S. Dakota (605) 225-0360.

DEMAG couplings are used for each gear box output shaft connection to the floating shafts. The other ends of the floating shafts are machined to use 1" diameter bore DUFF-NORTON flex-rigid gear couplings to match the DM-2811 jactuators. (SK2409, see page 43, D-N catalogue 172, Mechanical Actuators Design Guide).

calculation

load to be lifted per jactuator $= \left(\frac{\text{hammer wt. + crosshead ass'y wt.}}{2}\right)$

$= \left(\frac{6{,}000 + 1{,}000}{2}\right) = 3{,}500$ lb.

use 1800 RPM DEMAG main motor, F.L. RPM = 1700

use with 1:1 gear box, HUB CITY MODEL 828

therefore, RPM into each jactuator worm input shaft = 1700

Try jactuator model DM-2811, 10 T rated inverted rotating ball screw jactuator unit, two of (similar to model 2810 in capacity)

diameter of lifting screw = 1½"
lead = 0.474
worm gear ratio, use standard at 8:1
turns of worm for 1" raise = 16.888
maximum HP per jack = 5

now, jack raise per minute $= \frac{\text{RPM of worm shaft}}{\text{turns of worm for 1" raise}} = \frac{1700}{16.888} = 100.66$ in/min.

now, load per jack as a percentage of full capacity =

$$\frac{7000 \text{ lb.}}{10 \text{ tons} \times 2000 \frac{\text{lb.}}{\text{ton}} \times 2 \text{ jacks}} \times 100 = 17.5\%$$

(i.e. ok because we need less than 25% capacity as we are over 900 RPM, see page 62 D-N catalogue)

	Starting Torque Capacity (lb. - in.)	Running Torque Capacity (lb. - in.)
1/8 Capacity	55	50
0.175 Capacity (linear interpolation)	73	64
1/4 Capacity	100	85

holdback torque at rated load = 11 lb.-ft. (standard ratio)

$$\text{now HP per jack} = \frac{\text{lifting torque X RPM of worm}}{63{,}000} = \frac{(64)(1700)}{63{,}000} = 1.727$$

assumption: lifting torque = running torque

$$\text{arrangement HP} = \frac{\text{HP per jack X no. of jacks}}{\text{arrangement efficiency X efficiency of gear boxes}}$$

$$= \frac{(1.727)(2)}{(0.95)(0.9)} = 4.04$$

For maximum reliability purposes we've selected a DEMAG drive rated at 100% duty cycle even though you'll never operate the motors continuously. The extra cost is insignificant compared to overall system costs. An additional advantage here is that by derating the motor, a heavier hammer can be utilized, see DWG. 2009.

From page 11, DEMAG catalogue, select main motor KBA 112MA
*4.6 HP at 1700 RPM at 100% DF
14.1 lb.-ft. F.L. torque
brake torque at 100% DF 37.6 lb.-ft., conical standard brake disc
$wk^2 = 0.444$ lb.-ft.^{2}

Question: What is main motor overrun and brake time? (reference, pages 6, 35-37, DEMAG catalogue)

1st, calculate External wk^2 = Ballscrews wk^2 + load wk^2

ballscrews wk^2 inertia of rotating mass referred to motor

$$= \frac{\text{mass RPM}^2 \text{ X mass } wk^2}{\text{motor RPM}^2}$$

---

* 5.1 HP @ 1680 RPM @ 60% DF
5.8 HP @ 1700 RPM @ 40% DF
6.7 HP @ 1675 RPM @ 25% DF
7.9 HP @ 1645 RPM @ 15% DF

mass wk^2 of individual ball screw = 0.1 X ∫ X length in feet X
(dia. in feet)^4
where ∫ = 490 for steel
= 0.1(490)(approx. 12 feet) X (1.5inches/12)^4
= 0.14355 lb.-ft.^{2}
X 2 screws = 0.2871 lb.-ft.^{2}

now ballscrew RPM = 1700/8 = 212.5
now motor RPM = 1700

thus ballscrews wk^2 referred to motor $= \frac{(212.5)^2\,(0.2871)}{(1700)^2} = 0.00449$ lb.-ft.^{2}

now load wk^2 inertia of linear motion of crosshead assembly and hammer weight, referred to the motor

$$= \frac{(\text{linear speed})^2\ (\text{load})}{(\text{motor RPM})^2\ (\text{constant } 40)} = \frac{(100.66/12)^2\ \text{FPM X } 7000\ \text{lb.}}{(1700)^2\ \text{X } 40}$$

= 0.00426 lb.-ft.^{2}

therefore total External wk^2 = 0.00449 + 0.00426 = 0.00875 lb.-ft.^{2}

recall that arrangement HP = 4.04 at 1700 RPM

therefore load torque $T_L = \frac{4.04 \text{ X } 5252}{1700} = 12.48$ lb.-ft. < 14.1 lb.-ft. ✓

$$\text{brake time} = T_B = \frac{\text{RPM}\ (\Sigma wk^2 + \text{motor } wk^2)}{307\ (\text{motor brake torque} + \text{load torque})}$$

$$= \frac{1700\ (0.00875 + 0.444)}{307\ (37.6(0.9) - 12.48)} = 0.1174 \text{ seconds}$$

$$\text{overrun} = \frac{\text{linear speed X TB X } 12}{120} + \frac{\text{linear speed X transfer time* X } 12}{60}$$

$$= \frac{100.66/12 \text{ X } 0.1174 \text{ X } 12}{120} + \frac{100.66/12 \text{ X } 0.058 \text{ X } 12}{60}$$

= 0.1958 inches

ASTM E604-80 requirements suggest that drop height (actual) and drop height (measured) be no more than 1% apart.**

at a 3" probable minimum drop height, this = 0.01 X 3" = 0.03"

---

* see page 6, DEMAG catalogue

** the CANMET Heavy Section Fracture Testing Machine will be used for both instrumented and non-instrumented fracture testing

Therefore limiting overrun to 0.03" maximum will satisfy this requirement.

Question: What is the micromotor overrun and brake time?

$$\text{micromotor torque required} = \frac{\text{load torque}}{\text{gear reduction}} = \frac{12.48}{10 \text{(i.e. try 10:1 reduction)}}$$

$$= 1.248 \text{ lb.-ft.}$$

from page 10, select KBA 71A with 1.9 lb.-ft. F.L. torque at 100% D.F. Again, we do not need a 100% D.F. motor, but a choice of such is ultra conservative, and allows for derating if larger Hammers are used.*
0.59 HP at 1645 RPM at 100% D.F.
1.9 lb.-ft. F.L. torque
brake torque at 100% D.F., 4.05 lb.-ft., conical standard brake disc
$wk^2 = 0.036$ lb.-ft.^{2}

calculate External wk^2 referred to micromotor
= Ballscrews wk^2 + load wk^2

$$\text{now ballscrew } wk^2 \text{ referred to motor} = \frac{\text{mass RPM}^2 \times \text{mass } wk^2}{\text{motor RPM}^2}$$

$$= \frac{\left(1645/(8)(10)\right)^2 \times 0.2871}{(1645)^2}$$

$$= 0.0000449 \text{ lb.-ft.}^2$$

$$\text{load } wk^2 = \frac{(\text{linear speed})^2 \text{ load}}{(\text{motor RPM})^2 \times \text{constant } 40}$$

$$= \frac{\left(1645/(16.888)(12)(10)\right)^2 \times 7000 \text{ lb.}}{(1645)^2 \times 40}$$

$$= 0.0000426 \text{ lb.-ft.}^2$$

---

* 0.70 HP @ 1620 RPM @ 60% DF
0.78 HP @ 1625 RPM @ 40% DF
0.88 HP @ 1610 RPM @ 25% DF
1.05 HP @ 1555 RPM @ 15% DF

thus External wk^2 = 0.0000449 + 0.0000426 = 0.0000875 lb.-ft.^{2}

brake time = $T_B = \frac{1645\ (0.0000426 + 0.036)}{307\ (4.05\ (0.9) - 1.248)}$ = 0.0806 seconds

$$\text{overrun} = \frac{\left(1645/16.888\ (12)(10)\right)(0.0806) \times 12}{120}$$

$$+ \frac{\left(1645/16.888\ (12)(10)\right) 0.049 \times 12}{60}$$

= 0.0145 inches

repeatability = ±0.0145 inches, or a range of 0.029 inches, <0.03"

As a crosscheck, use the DUFF-NORTON relationship to check the brake capacity of both the main motor and micromotor; reference, page 30, D-N catalogue excerpts

$$\underset{\text{(lb.-ft.)}}{\text{motor brake torque}} = \frac{C}{\text{turns of worm for 1" raise} \times \text{drift} \times \text{reducer ratio}}$$

$$+ \frac{\text{holdback torque} \times \text{no. of jacks}}{\text{reducer ratio}}$$

for main motor DEMAG KBA 112MA at 1700 RPM at 4.6 HP, C = 77.05 (interpolated)
brake torque capacity = 37.6 lb.-ft.
holdback torque per jack = 3500/20,000 X 11 lb.-ft. = 1.925 lb.-ft.
turns of worm for 1" raise = 16.888
drift (with main motor) = 0.1958 inches
drift (with micromotor) = 0.0145 inches
reducer ratio (with main motor) = 1
reducer ratio (with micromotor) = 10
for micromotor DEMAG KBA 71A at 1645 RPM at 0.59 HP, C = 6.93 (interpolated)
brake torque capacity = 4.05 lb.-ft.

thus motor brake torque required for main motor =

$$\frac{77.05}{16.888 \times 0.1958 \times 1} + \frac{1.925 \times 2}{1} = 27.15 \text{ lb.-ft.}$$

this is less than 37.6 lb.-ft. ✓

motor brake torque required for microspeed motor =

$$\frac{6.93}{16.888 \times 0.0145 \times 10} + \frac{1.925 \times 2}{10} = 3.22 \text{ lb.-ft.}$$

this is less than 4.05 lb.-ft. ✓

For drop height instrumentation use the Quality Measurement Systems Model 1110 transducer with Model 4051 digital display in the remote console.

With the Quality Measurement Systems transducer and digital display package, the operator can advance at fast speed to the approximate drop height he wants and then go to microspeed advance to crawl to the final drop height. Also, the microspeed motor will be very handy in slow re-engagement of the toggle release to the hammer.

The microspeed motor advance will be particularly convenient in establishing a zero height position for a specimen. For example, if a 100 mm deep specimen is to be fractured,the zero position at the top of the specimen can be established by placing a dummy aluminum (lightweight) block of 100 mm depth on the anvils. Once near the anvils, the microspeed motor advance will allow precise positioning of the TUP on the dummy block surface. Then press reset on the 4051 digital console. Select metric or imperial readout. Now raise the hammer to the required drop height by watching the digital readout follow the upward travel.

The Model 1110 transducer in conjunction with the QMS Model 4051 digital readout is a self contained system with 115VAC power requirements.

AIR CYLINDERS DIRECTIONAL CONTROL VALVES, ACCESSORIES

Drawings 2002 and 2006-3 show the Latch Trip air cylinder. There is one only. It has a 2" diameter bore, 0.625" diameter rod, and 3" stroke. The initial force required from this cylinder to open the latch can be calculated. With reference to the latch trip illustrated on the next page, note the following:

With two cavities filled with lead in the hammer, plus the Latch hook assembly, we have a dead weight of approximately 6,000 lbs. = $R_1 + R_2$

With five cavities filled with lead in the hammer, plus the Latch hook assembly, we have a dead weight of approximately 10,320 lbs. = $R_1 + R_2$

From the relationships shown on the next page, note that

$$R_4 = 2\left[R_2\left(\frac{2.3}{8.0}\right)(\text{SIN } 11^\circ - 40')\right]\left(\frac{2.5}{4.3}\right)$$

$$= 0.0676\ R_2$$

where R_2 = one half the weight of the hammer plus Latch hook assembly (DWG's 2004 and 2009)

R_4 = initial retraction force required by the Latch cylinder

Calculation one (2 cavities lead filled)

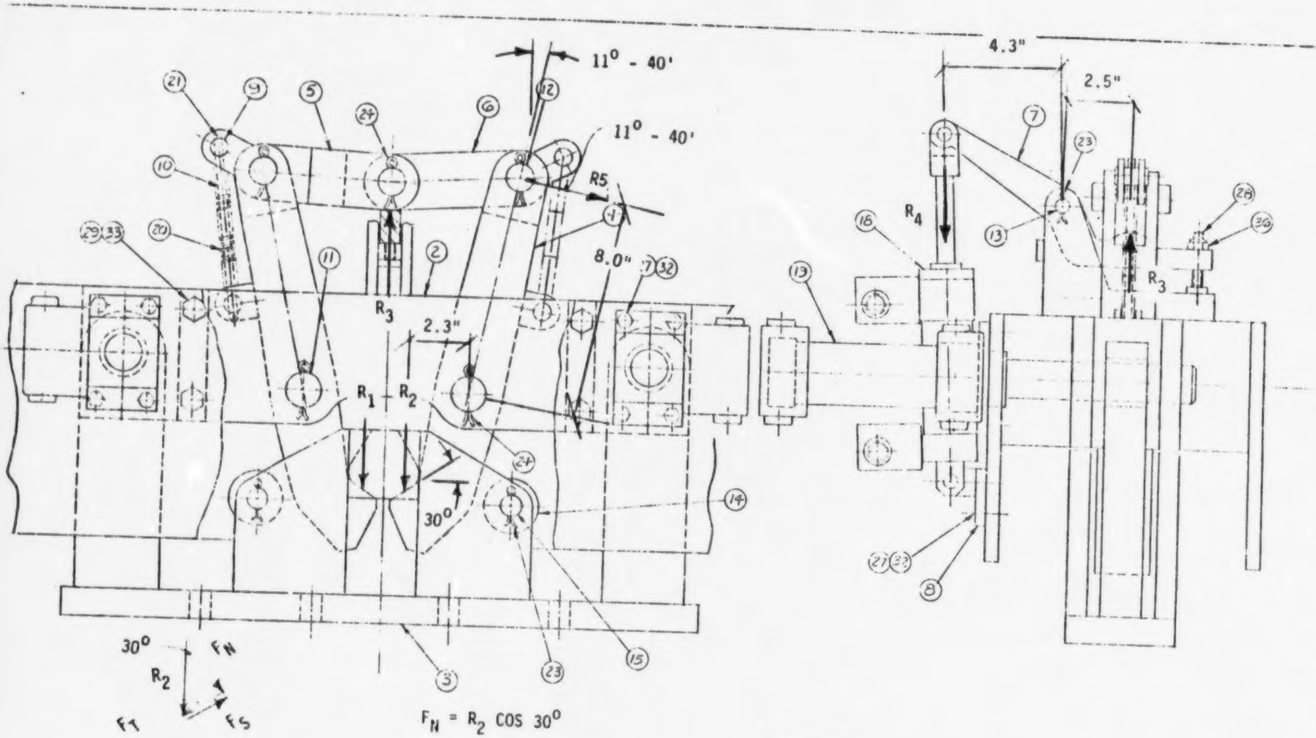
$$R_4 = 0.0676\left(\frac{6000}{2}\right) = 202.8 \text{ lbs.}$$

Our cylinder has 2" diameter bore x 0.625" diameter rod

The area pressurized when retracting = $\frac{\pi}{4}\left[(2)^2 - (0.625)^2\right] = 2.83 \text{ in.}^2$

Thus the Latch Trip cylinder operating pressure requirement =

$$\frac{202.8}{2.83} = 71.7 \text{ PSIG}$$



$F_N = R_2 \cos 30^\circ$

$F_T = R_2 \sin 30^\circ$

$F_{\text{tangential, one side}} = 3{,}000 \sin 30^\circ = 1{,}500$ lbs.

The maximum static resiting force = $F_{S\ \max} = f_s F_N$, where

f_s = coefficient of static friction

for hard steel on hard steel, this can range from

0.78 (dry) to 0.11 (greasy)

Thus $F_{S\ \max}$ RANGE = $(0.78)\ 3{,}000 \cos 30^\circ \rightarrow (0.11)\ 3{,}000 \cos 30^\circ$

$= 2026.5$ lbs. $\rightarrow 285.9$ lbs.

CONCLUSION: Using some grease (suggest molybdenum disulphide EP) will eliminate the need for the Latch Trip cylinder to be sized to handle a net static resisting force. Rather there will be an overrunning Latch release force.

Relationships

$R_2(2.3) = R_5(8.0)$ ---------- (1)

$R_1 = R_2$ ---------- (2)

$2\left[R_5(\sin 11^\circ - 40')\right] = R_3$ ---------- (3)

$R_3(2.5) = R_4(4.3)$ ---------- (4)

We want R_4 in terms of R_2

Thus $R_4 = 2\left[R_2\frac{(2.3)}{(8.0)}(\sin 11^\circ - 40')\right]\frac{(2.5)}{(4.3)}$ ---- (5)

Allan Malinoski
May 3, 1983

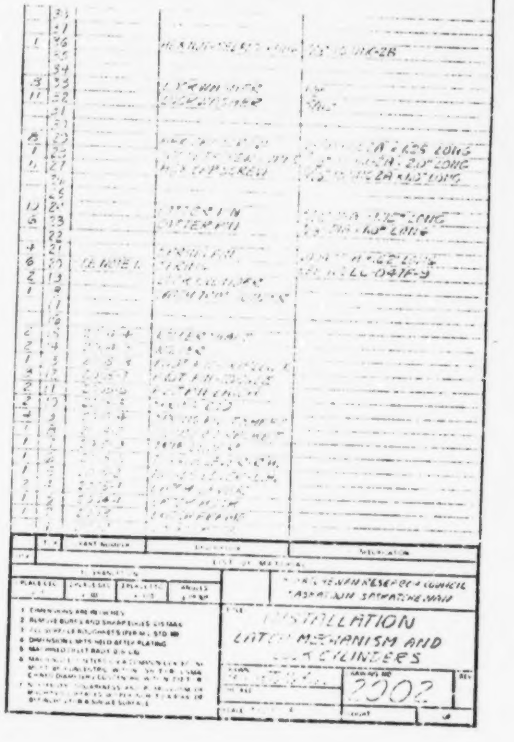
R_4 = load exerted by Latch Trip cylinder when starting to retract

R_3 = latch release force due to R_4

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER [illegible]
DSS CONTRACT SERIAL NUMBER [illegible]
CANMET PROJECT NUMBER [illegible]


LIST OF MATERIAL

PART NUMBER

DESCRIPTION

SPECIFICATION

INSTALLATION LATCH MECHANISM AND ... CYLINDERS

2002

L. LEE SPRING CO. - 30 MAIN ST. BROOKLYN N.Y. 11201

NOTES:

Calculation two (5 cavities lead filled)

$$R_4 = 0.0676\left(\frac{10,320}{2}\right) = 348.8 \text{ lbs.}$$

Thus the Latch Trip cylinder operating pressure requirement =

$$\frac{348.8}{2.83} = 123.3 \text{ PSIG}$$

This cylinder will be controlled by a single, 4-Way, 5-Port, 2-Position Double Solenoid Valve, PARKER 4501 Series, 120 VAC, 60 Hertz coils, 1/4" NPTF Valve Port Size. Use Model No. 4501A S10 A AAA53, non-ISO model with side ported subbase. Note that an ISO model is also available. Locate the valve on the crosshead near the cylinder.

In ports 3 and 5 locate PARKER SP-25 port speed controls.

Question:	What minimum SCFM do we require?
Answer:	In terms of operating requirements there is no particular Latch Trip air cylinder speed that is more desireable than another. Preliminary calculations indicate the suitability of using the PARKER Basic 1/8" Body FRL (Filter-Regulator-Lubricator) unit. The Mist air line Lubricator in this series has a minimum flow for lubrication requirement of 0.8 SCFM @ 100 PSI

$$\text{Now, Compression Ratio} = \frac{\text{Pressure at cylinder (PSIG) + Absolute Pressure (PSIA)}}{\text{Absolute Pressure at Site (PSIA)}}$$

$$= \frac{100 + 14.7}{14.7} = 7.80$$

a) The retraction displaced Volume = A x S = 2.83 x 3 = 8.49 in.^{3}

where $A = \frac{\pi}{4}\left[(2)^2 - (0.625)^2\right] = 2.83$ in.^{2} (piston area - rod area)

S = 3" (stroke)

b) The extension displaced Volume = A x S = 3.14 x 3 = 9.42 in.^3

where $A = \frac{\pi}{4}(2)^2 = 3.14^2$ (piston area)

S = 3" (stroke)

Now $\text{SCFM} = \frac{V(\text{in.}^3) \times \text{Compression Ratio}}{\text{Time to Fill Cylinders} \times 28.8}$ (conversion constant)

rewritten, time to fill cylinders $= \frac{V(\text{in.}^3) \times \text{Compression Ratio}}{\text{SCFM} \times 28.8} = T$

Thus the minimum $T_{a)} = \frac{(8.49)(7.80)}{(0.8)(28.8)} = 2.87$ seconds

Therefore $\frac{3\text{" stroke}}{2.87 \text{ seconds}} \times \frac{60 \text{ sec.}}{\text{minute}} = 62.7$ inches/minute minimum required Latch Trip air cylinder retraction speed

Thus the minimum $T_{b)} = \frac{(9.42)(7.80)}{(0.8)(28.8)} = 3.19$ seconds

Therefore $\frac{3\text{" stroke}}{3.19 \text{ seconds}} \times \frac{60 \text{ sec.}}{\text{minute}} = 56.4$ inches/minute minimum required Latch Trip air cylinder extention speed

Recommendation - set SP-25 port speed controls in ports 3 and 5 for approximately 65 inches/minute Latch Trip cylinder extension and retraction stroke speeds

- set regulator @ 100 - 125 PSIG (assuming 6,000 lb. hammer Latch hook assembly)

Note that at less than 1 SCFM the pressure drop across the PARKER 4501 series valve is negligible. We are using the 1/4" NPTF valve size configuration in all cylinder cases, as this is the smallest port size accessible in the SP port speed control valves, i.e. SP-25's.

Both the Latch Trip air cylinder and Crosshead/Hammer air cylinders (DWG 2006-1) move with the crosshead. As they are not actuated at the same time they can be served by a common air pressure source through a common FRL assembly located on the Crosshead. As the Crosshead moves, the air input line must be suspended and looped with sufficient slack to allow for this movement without entangling or crimping it.

As regards the Crosshead/Hammer air cylinders, the retraction and extension displaced Volumes are equal and = A x S = 1.66 x 2 of x 4 = 13.28 in.^{3}

where $A = \frac{\pi}{4}\left[(2)^2 - (1\ 3/8)^2\right] = 1.66$ in.^{2} (piston area - rod area)

S = 4" (stroke)

Thus the minimum $T = \frac{(13.28)(7.80)}{(0.8)(28.8)} = 4.50$ seconds

therefore $\frac{4\text{" stroke}}{4.50 \text{ seconds}} \times \frac{60 \text{ sec.}}{\text{minute}} = 53.3$ inches/minute minimum required Crosshead/Hammer air cylinders extension and retraction speeds

Recommendation - set SP-25 port speed controls in ports 3 and 5 for approximately 55 inches/minute Crosshead/Hammer air cylinders extension and retraction stroke speeds

Note that the Crosshead/Hammer air cylinders are also controlled by a PARKER 4501A S10 A AAA53 directional control valve located on the Crosshead adjacent to the cylinders.

The FRL assembly common to the Latch Trip cylinder and Crosshead/Hammer cylinders should be located on the Crosshead near the cylinders. It consists of:

Filter - PARKER 04F-1-1-B Minature Series
i.e. 1/4 NPTF port size, polycarbonate bowl manual drain, 5 micron element.

Regulator - PARKER 04R-1-18-F Minature Series
i.e. 1/4 NPTF port size, pressure range to 125 psi with gauge, knob adjustment, unbalanced poppet, relieving

Lubricator - PARKER 04L-1-0-B Minature Series
i.e. 1/4 NPTF port size, polycarbonate bowl manual drain, without tamper proof cap.

PARKER Three-Unit FRL Combination Number = 04A11B18E0B

Note that polycarbonate bowls should not be exposed to chlorinated hydrocarbons, ketones, esters and certain alcohols. They should not be used in air systems where compressors are lubricated with fire-resistant fluids such as phosphate ester and di-ester types. If any of the above is a problem, use metal bowls.

The Frame/Crosshead air cylinders (DWG 2006-2) are a separate circuit. They use the same directional control valve type, port speed controls, and FRL unit. Locate the valve and FRL unit on the frame near the two cylinders.

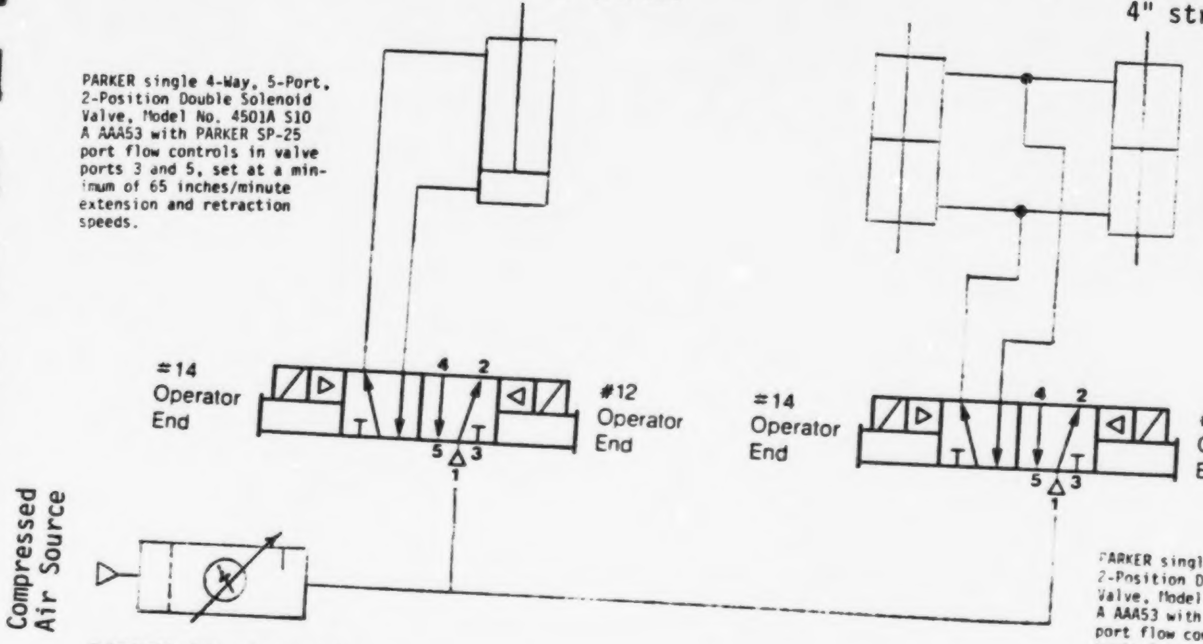
Recommendation - set SP-25 port speed controls in ports 3 and 5 for approximately 55 inches/minute Frame/Crosshead air cylinders extension and retraction stroke speeds
- set the regulator to 100 - 125 PSIG

In the use of both FRL units, the suggested lubricant is a petroleum based oil of 100 to 200 SSU viscosity of $100^{\circ}F$ and an aniline point greater than $200^{\circ}F$. Do not use oils with adhesives, compounded oils containing solvents, graphite, detergents, or synthetic oils.

The following page illustrates both circuits schematically.

Latch Trip Air Cylinder
2" diameter bore
5/8" diameter rod
3" stroke

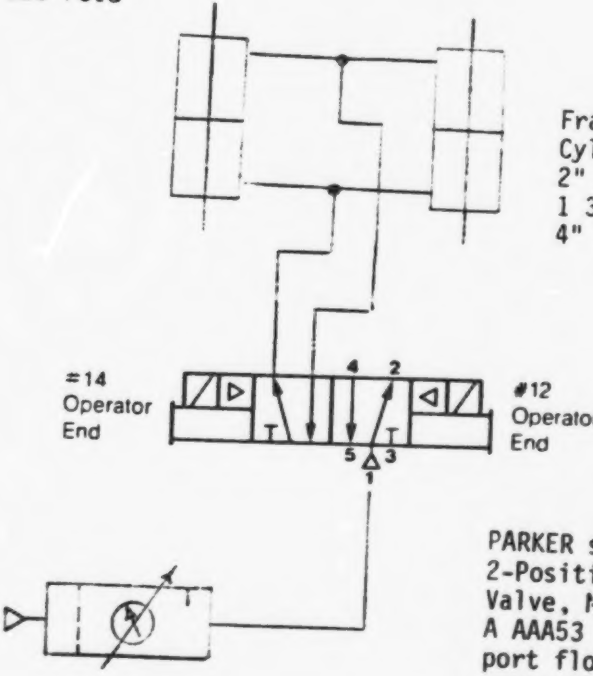
Crosshead/Hammer Ai
Cylinders
2" diameter bore
1 3/8" diameter rod
4" stroke


#14
Operator
End
4
2
T
5
3
1
#12
Operator
End
#14
Operator
End
4
2
T
5
3
1
#12
Operator
End
Compressed
Air Source

PARKER single 4-Way, 5-Port, 2-Position Double Solenoid Valve, Model No. 4501A S10 A AAA53 with PARKER SP-25 port flow controls in valve ports 3 and 5, set at a minimum of 65 inches/minute extension and retraction speeds.

PARKER single 4-Way, 5-Port, 2-Position Double Solenoid Valve, Model No. 4501A S10 A AAA53 with PARKER SP-25 port flow controls in valve ports 3 and 5, set at a minimum of 55 inches/minute extension and retraction speeds.

PARKER FRL Assembly
Three-Unit Combination No.
04A11B18E0B
set regulator @ 100 - 125 PSIG

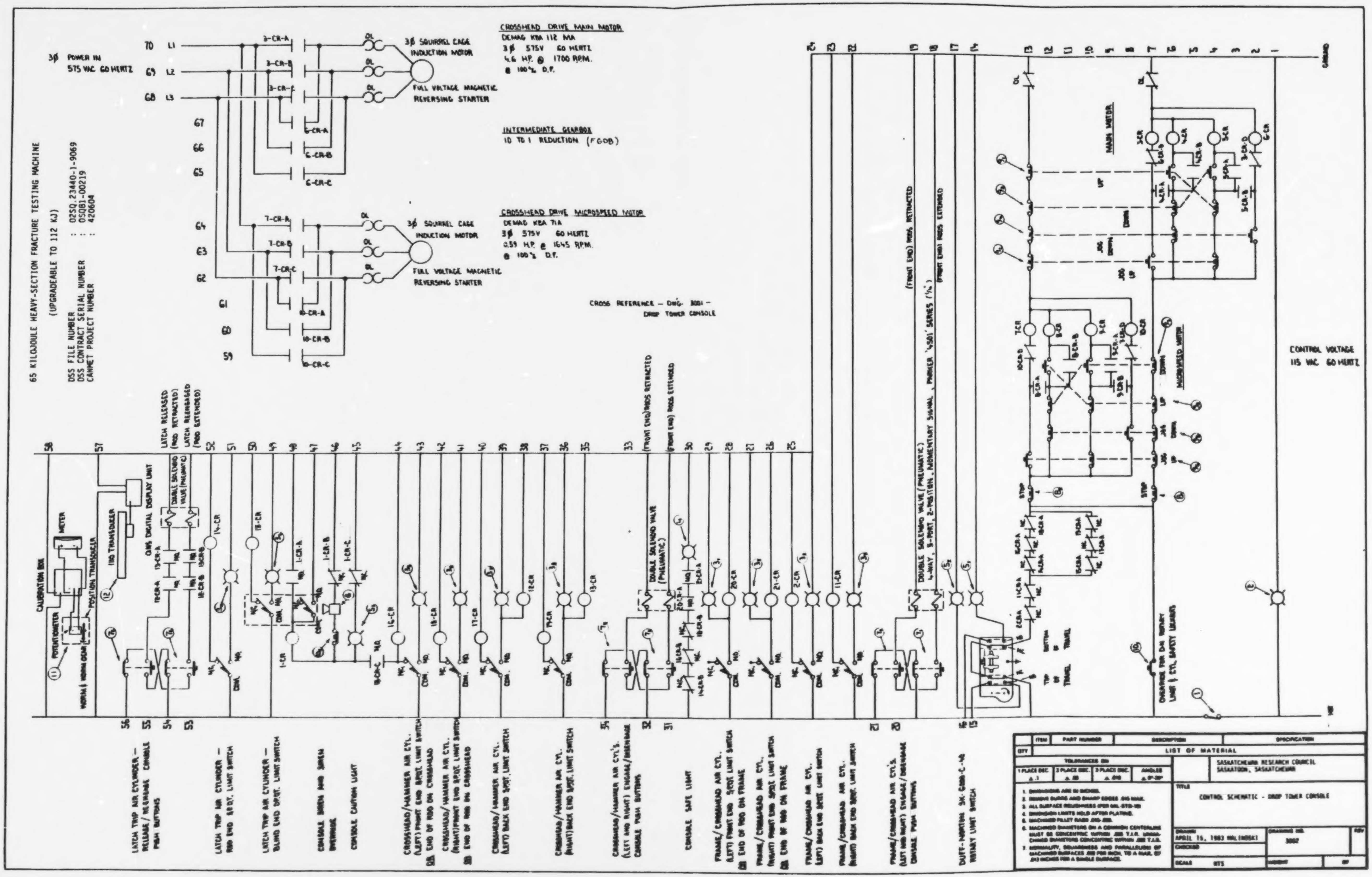

#14
Operator
End
4
2
T
5
3
1
#12
Operator
End

Frame/Crosshead Air
Cylinders
2" diameter bore
1 3/8" diameter rod
4" stroke

Compressed
Air Source

PARKER single 4-Way, 5-Port, 2-Position Double Solenoid Valve, Model No. 4501A S10 A AAA53 with PARKER SP-25 port flow controls in valve ports 3 and 5, set at a minimum of 55 inches/minute extension and retraction speeds.

PARKER FRL Assembly
Three-Unit Combination No.
04A11B18E0B
set regulator @ 100 - 125 PSIG


65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE
(UPGRADEABLE TO 112 KJ)
DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 05QB1-00219
CANMET PROJECT NUMBER : 420604
3∅ POWER IN
575 VAC 60 HERTZ
70 L1
69 L2
68 L3
3-CR-A
3-CR-B
3-CR-C
6-CR-A
6-CR-B
6-CR-C
7-CR-A
7-CR-B
7-CR-C
10-CR-A
10-CR-B
10-CR-C
OL
3∅ SQUIRREL CAGE INDUCTION MOTOR
FULL VOLTAGE MAGNETIC REVERSING STARTER
CROSSHEAD DRIVE MAIN MOTOR
DEMAG KBA 112 MA
3∅ 575V 60 HERTZ
4.6 HP @ 1700 RPM.
@ 100% D.F.
INTERMEDIATE GEARBOX
10 TO 1 REDUCTION (FG08)
CROSSHEAD DRIVE MICROSPEED MOTOR
DEMAG KBA 71A
3∅ 575V 60 HERTZ
0.59 HP @ 1645 RPM.
@ 100% D.F.
CROSS REFERENCE – DWG. 3001 – DROP TOWER CONSOLE
MAIN MOTOR
MICROSPEED MOTOR
UP
DOWN
JOG DOWN
JOG UP
STOP
CONTROL VOLTAGE
115 VAC 60 HERTZ
GROUND
OVERRIDE FOR DM ROTARY LIMIT & CYL. SAFETY LIGHTS
TRIP OF TRAVEL
BOTTOM OF TRAVEL
(FRONT END) RODS RETRACTED
(FRONT END) RODS EXTENDED
DOUBLE SOLENOID VALVE (PNEUMATIC)
4-WAY, 5-PORT, 2-POSITION, MOMENTARY SIGNAL, PARKER '4501' SERIES (¼)
LATCH RELEASED (ROD RETRACTED)
LATCH REENGAGED (ROD EXTENDED)
DOUBLE SOLENOID VALVE (PNEUMATIC)
CAMS DIGITAL DISPLAY UNIT
130 TRANSDUCER
POSITION TRANSDUCER
METER
CALIBRATION BOX
POTENTIOMETER
WORM & WORM GEAR
NO
NC
COM.
LATCH TRIP AIR CYLINDER – RELEASE / REENGAGE CONSOLE PUSH BUTTONS
LATCH TRIP AIR CYLINDER – ROD END SPDT. LIMIT SWITCH
LATCH TRIP AIR CYLINDER – BLIND END SPDT. LIMIT SWITCH
CONSOLE SIREN AND SIREN OVERRIDE
CONSOLE CAUTION LIGHT
CROSSHEAD/HAMMER AIR CYL. (LEFT) FRONT END SPDT. LIMIT SWITCH END OF ROD ON CROSSHEAD
CROSSHEAD/HAMMER AIR CYL. (RIGHT) FRONT END SPDT. LIMIT SWITCH END OF ROD ON CROSSHEAD
CROSSHEAD/HAMMER AIR CYL. (LEFT) BACK END SPDT. LIMIT SWITCH
CROSSHEAD/HAMMER AIR CYL. (RIGHT) BACK END SPDT. LIMIT SWITCH
CROSSHEAD/HAMMER AIR CYL'S. (LEFT AND RIGHT) ENGAGE/DISENGAGE CONSOLE PUSH BUTTONS
CONSOLE SAFE LIGHT
FRAME/CROSSHEAD AIR CYL. (LEFT) FRONT END SPDT LIMIT SWITCH END OF ROD ON FRAME
FRAME/CROSSHEAD AIR CYL. (RIGHT) FRONT END SPDT LIMIT SWITCH END OF ROD ON FRAME
FRAME/CROSSHEAD AIR CYL. (LEFT) BACK END SPDT LIMIT SWITCH
FRAME/CROSSHEAD AIR CYL. (RIGHT) BACK END SPDT. LIMIT SWITCH
FRAME/CROSSHEAD AIR CYL'S. (LEFT AND RIGHT) ENGAGE/DISENGAGE CONSOLE PUSH BUTTONS
DUFF-NORTON SK-6000-C-40 ROTARY LIMIT SWITCH
ITEM
PART NUMBER
DESCRIPTION
SPECIFICATION
QTY
LIST OF MATERIAL
TOLERANCES ON
1 PLACE DEC. ±.1
2 PLACE DEC. ±.03
3 PLACE DEC. ±.010
ANGLES ±0°-30'
SASKATCHEWAN RESEARCH COUNCIL
SASKATOON, SASKATCHEWAN
TITLE
CONTROL SCHEMATIC – DROP TOWER CONSOLE
DRAWN
APRIL 15, 1983 MALINOSKI
DRAWING NO.
3002
REV
CHECKED
SCALE NTS
WEIGHT
OF

COMMENTARY ON MECHANICAL/STRUCTURAL DRAWINGS 2001 - 2020

The following drawings are largely self explanatory. However, in conjunction with these, the following should be kept in mind:

1. Occasionally, fracture testing may result in specimen fragments flying out from the anvils in unpredictable directions. We designed the fracture testing machine assembly without incorporating an integral safety containment screen. For a tester of this size we recommend that the drop tower console be located behind a safety wall adjacent to the tester. One arrangement would be to use concrete and rebar concrete block construction with an impact resistant plexiglass window.

2. If an operations instruction manual is required in a format which will give any beginning user sufficient information to use the system quickly, effectively and safely, we recommend that it be written by the fabricator based on the information in this report and his acquired knowledge of the fracture testing machine during its construction.

3. As an additional check the fabricator should be responsible for verifying the assembly dimensional integrity of these drawings. If any discrepancies are found, they should be pointed out to CANMET and/or SRC for correction prior to fabrication

4. All shop drawings prepared by the fabricator should be reviewed by CANMET prior to usage.

PRODUCTION CHART
WRITER Tells Go APR 26-83
PART NO. 2017
REV.
SH 1 OF 5
TITLE FRACTURE TESTING MACHINE ASSEMBLY
CUSTOMER
P.O. NO.
QUANTITY
JOB NO.
RELEASE DATE
DUE DATE

NO.	PART NO.	DESCRIPTION	SPECIFICATIONS	UNIT QTY	JOB QTY	P.O. NO.	DATE		REC'D	
1	2017	FRACTURE TESTING MACHINE ASSY		1						
2	2001	HOISTING MECHANISM		1						
3	2002	INSTR.-LATCH MECHANISM		1						
4	2003-1	LATCH FRAME WELDMENT		1						
5	-2	PLATE	ASTM-A36 HFS-1.00 THICK × 4.75 × 13.0	2						
6	-3	PLATE	ASTM-A36 HFS-1.00 THICK × 4.75 × 9.0	2						
7	-4	PLATE	ASTM-A36 HFS-.75 THICK × 3.5 × 4.75	4						
8	-5	EAR	ASTM-A36 HFS-.375 THICK × 4.62 × 6.25	2						
9	-6	BAR	AISI 1020 HFS-.25 × .75 × 1.2 LG	2						
10										
11	2004-1	LATCH HOOK WELDMENT		1						
12	-8	BASE	AISI 1020 HFS-1.00 × 4.00 × 23.0 LG	1						
13	-9	LATCH BLOCK	AISI 1020 HFS-2.50 SQUARE × 4.0 LG	1						
14	-10	BLADE	AISI 1020 HFS-1.50 × 3.00 × 10.0 LG	2						
15	-11	SIDE PLATE	ASTM-A36 HFS-.75 THICK × 4.12 × 6.0	4						
16										
17	2005-1	LATCH LEVER WELDMENT		2						
18	-15	LATCH LEVER	ASTM-A36 HFS-2.00 THICK × 2.75 × 15.0	2						
19	-16	EAR	AISI 1020 HFS-.25 × 1.25 × 1.38	4						
20										
21	2005-2	TOGGLE LEVER-L.H.		1						
22	-18	ARM	AISI 1020 HFS-1.00 × 2.00 × 4.0 LG	1						
23	-19	CLEVIS PLATE	AISI 1020 HFS-.50 × 2.00 × 4.0 LG	2						
24	-20	EAR	AISI 1020 HFS-.25 × 1.25 × 1.38	2						
25										
26	2005-3	TOGGLE LEVER-R.H.		1						
27	-20	EAR	AISI 1020 HFS-.25 × 1.25 × 1.38 LG	1						
28	-22	ARM	AISI 1020 HFS-1.00 × 2.00 × 6.66 LG	1						
29										
30	2005-9	TRIP LEVER	ASTM-A36 HFS-.75 THICK × 2.8 × 11.4	1						
31	2004-2	CYLINDER BRACKET WELD		1						
32	-6	BASE	AISI 1020 HFS-.38 × 2.00 × 4.0 LG	1						
33	-7	EAR	AISI 1020 HFS-.75 × 1.00 × 1.62 LG	1						
34										
35	2005-4	SPRING PIVOT SHAFT	STN STEEL-TYPE 304 C.F.-.625 DIA × 1.2 LG	4						
36	2005-5	SPRING ROD	STN. STEEL-TYPE 304 C.F.-.312 DIA × 7.09 LG	2						
37	2005-6	PIVOT PIN-LATCH	STN. STEEL-TYPE 304 C.F.-1.250 DIA × 5.5 LG	2						
38	2005-7	PIVOT PIN-TOGGLE	STN. STEEL-TYPE 304 C.F.-1.000 DIA × 2.89 LG	3						
39	2005-8	PIVOT PIN-TRIP LEVER	STN. STEEL-TYPE 304 C.F.-.500 DIA × 2.3 LG	1						
40	2004-3	ROLLER	AISI 1018 CFS-2.00 DIA × 2.38 LG	2						
41	2004-4	ROLLER SHAFT	STN. STEEL-TYPE 304 C.F.-.750 DIA × 4.65 LG	2						
42										
43										
44	2006-3	LATCH TRIP CYLINDER	SEE DRAWING	1						
45	2006-1	LOCK CYLINDER	SEE DRAWING	2						
46	2002-20	SPRING	LEE SPRING CO. № LC-047F-9	6						
47	-21	SPRING PIN	.094 DIA × .62 LONG	4						
48										
49	-23	COTTER PIN	1/8 DIA × 1.0 LONG	6						
50	-24	COTTER PIN	3/16 DIA × 1.75 LONG	10						

PART NO. 2017
REV.
SH 1 OF 5

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 025Q.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

PRODUCTION CHART	**WRITER** Tellefson APR 26-83	**PART NO.** 2017	**REV**	**SH** 2 **OF** 5	**TITLE** FRACTURE TESTING MACHINE ASSEMBLY	**CUSTOMER**
P.O. NO.	**QUANTITY**	**JOB NO.**		**RELEASE DATE**	**DUE DATE**	

PART NO.	DESCRIPTION	SPECIFICATIONS	UNIT QTY	JOB QTY	P.O. NO.	DATE		REC'D	
2017	FRACTURE TESTING MACHINE ASSY	CONTINUED	1						
2002	INSTL.-LATCH MECHANISM	CONTINUED	1						
2002-27	HEX CAP SCREW	5/16-18 UNC-2A × 1.0 LONG	11						
-28	SOC SET SCREW-CUP PT.	3/8-16 UNC-2A × 2.0 LONG	1						
-29	HEX CAP SCREW	1/2-13 UNC-2A × 1.25 LONG	8						
-32	LOCK WASHER	5/16	11						
-33	LOCK WASHER	1/2	8						
-36	HEX NUT-SELF LOCKING	3/8-16 UNC-2B	1						
2007-2	PLATFORM WELDMENT		1						
-3	PLATFORM	ASTM-A36 HFS-.75 THICK × 72.0 × 102.0	1						
-4	FLANGE	AISI 1020 HFS-.50×6.00 × 72.0 LG	2						
-5	FLANGE	AISI 1020 HFS-.50×6.00×102.0 LG	2						
2008-1	CROSS HEAD PLATE-FRONT	ASTM-A36 HFS-.50 THICK × 9.0×94.0	1						
-2	CROSSHEAD PLATE-REAR	ASTM-A36 HFS-.50 THICK × 9.0×94.0	1						
-3	NUT PLATE	ASTM-A36 HFS-1.50 THICK × 7.0 × 9.0	2						
2008-4	LOCK BRACKET WELDMENT		2						
-9	BASE	AISI 1020 HFS-1.50×4.00 × 9.0 LG	2						
-10	EAR	AISI 1020 HFS-1.50×3.00 × 7.0 LG	2						
2008-5	GUIDE WELDMENT		2						
-11	BASE	ASTM-A36 HFS-1.00 THICK × 9.0 × 9.0	2						
-12	GUIDE	AISI 1018 CFS-1.50× 2.00 × 6.0 LG	2						
2008-6	CYLINDER BRACKET WELDMENT		2						
-13	BASE	AISI 1020 HFS-1.00 × 5.00 × 9.0 LG	1						
-14	EAR	AISI 1020 HFS-1.50×3.00 × 9.0 LG	1						
-15	EAR	AISI 1020 HFS-.75 ×3.00 × 9.0 LG	1						
2007-9	SPACER BLOCK	ASTM-A36 HFS-1.50 THICK × 1.614 × 5.4	2						
-10	SPACER BLOCK	ASTM-A36 HFS-1.50 THICK × 2.159 × 7.25	4						
-12	DRIVE SHAFT	AISI 1018 CFS-28 MM DIA × 30.9"	2						
-11	SPACER-PILLOW BLOCK	ASTM-A36 HFS-1.50 THICK × 3.562 × 5.0	2						
2006-2	LOCK CYLINDER	SEE DRAWING	2						
2001-17	DRIVE MOTOR	MANNESMANN DEMAG:	1						
		MAIN MOTOR № KB112MA							
		INTERMEDIATE GEAR BOX № FG08							
		MICROMOTOR № KB71A							

PART NO.	REV.	SH	OF
2017		2	5

PRODUCTION CHART	WRITER	PART NO.	REV	SH	TITLE	CUSTOMER	P.O. NO.	QUANTITY	JOB NO.	RELEASE DATE	DUE DATE
	Tellefson APR 27-83	2017		3 OF 5	FRACTURE TESTING MACHINE ASSEMBLY						

NO.	PART NO.	DESCRIPTION	SPECIFICATIONS	UNIT QTY	JOB QTY	P.O. NO.	DATE		REC'D	
	2017	FRACTURE TESTING MACHINE ASSY	CONTINUED	1						
	2001	HOISTING MECHANISM	CONTINUED	1						
3	2001-18	BEVEL GEAR BOX	HUB CITY MODEL 828 - 1:1 GEAR RATIO	1						
	-19	BALL SCREW JACK	DUFF NORTON Nº DM-2811 WITH	2						
			SCREW - 144" LONG							
6	-20	MOTOR COUPLING	DEMAG Nº HZN-28	3						
	-21	BALL SCREW COUPLING	DUFF NORTON Nº SK-2409	2						
	-22	PILLOW BLOCK	DODGE Nº SC-1" SHAFT	2						
9	-23	LIMIT SWITCH	DUFF NORTON Nº SK-6000-C-40	1						
	-24	POSITION TRANSDUCER	DUFF NORTON Nº SK-6200-T-40	1						
11										
	-26	HEX CAP SCREW	M12 x 45 MM LONG	4						
	-27	HEX CAP SCREW	M12 x 45 MM LONG	4						
14	-28	HEX NUT	M12	4						
	-29	LOCK WASHER	M12	8						
	-30	HEX CAP SCREW	5/16-18 UNC-2A x 1.0 LONG	8						
17	-31	HEX CAP SCREW	3/8-16 UNC-2A x 6.0 LONG	4						
	-32	HEX CAP SCREW	1/2-13 UNC-2A x 1.25 LONG	24						
	-33	HEX CAP SCREW	1/2-13 UNC-2A x 2.0 LONG	12						
20	-34	HEX CAP SCREW	1/2-13 UNC-2A x 2.25 LONG	16						
	-35	HEX CAP SCREW	3/4-10 UNC-2A x 3.75 LONG	8						
22	-36	HEX CAP SCREW	3/4-10 UNC-2A x 2.5 LONG	8						
	-37	LOCK WASHER	5/16	8						
	-38	LOCK WASHER	3/8	4						
25	-39	LOCK WASHER	1/2	44						
	-40	LOCK WASHER	3/4	16						
28	-42	FLAT WASHER	3/8	4						
31	-45	HEX NUT	3/8-16 UNC-2B	4						
	-46	HEX NUT	1/2-13 UNC-2B	44						
	-47	HEX NUT	3/4-10 UNC-2B	16						
34										
36	2018	HAMMER ASSEMBLY		1						
	2009-1	HAMMER WELDMENT		1						
	-2	BEAM - WIDE FLANGE	ASTM-A36 HFS - 8.0" x 67 LB x 64.0 LG	5						
39	-3	SIDE RAIL	ASTM-A36 HFS - 2.00 THICK x 7.5 x 64.0	2						
	-4	BOTTOM PLATE	ASTM-A36 HFS - 2.00 THICK x 7.5 x 43.0	1						
	-5	TOP PLATE	ASTM-A36 HFS - 1.00 THICK x 7.5 x 43.0	1						
42										
	-7	LEAD	1440 LBS (3512 CUBIC INCHES)	2						
45	2010-1	HAMMER GUIDE WELDMENT		2						
	-11	BASE PLATE	AISI 1020 HFS - .75 x 4.00 x 60.0 LG	2						
47	-12	GUIDE BAR	AISI 1020 HFS - 1.50 x 2.00 x 60.0 LG	2						
	2010-4	TOP PLATE	ASTM-A36 HFS - 1.00 THICK x 7.5 x 43.0	1						
50										

PART NO.	REV.	SH
2017		3 OF 5

PRODUCTION CHART
WRITER Tellefson APR 27-83
PART NO. 2017
REV
SH 4 OF 5
TITLE FRACTURE TESTING MACHINE ASSEMBLY
CUSTOMER
P.O. NO.
QUANTITY
JOB NO.
RELEASE DATE
DUE DATE

PART NO.	DESCRIPTION	SPECIFICATIONS	UNIT QTY	JOB QTY	P.O. NO.	DATE	REC'D
2017	FRACTURE TESTING MACHINE ASSY	CONTINUED	1				
2018	HAMMER ASSEMBLY	CONTINUED	1				
2010-5	BOTTOM PLATE	ASTM-A36 HFS -2.00 THICK × 7.5 × 43.0	1				
2010-6	STRIKER	AISI 4150 HFS -1.50 × 4.00 × 7.5 LG	2				
2018-10	HEX CAP SCREW	1/2-13 UNC-2A × 1.5 LONG	36				
-11	HEX CAP SCREW	1/2-13 UNC-2A × 2.0 LONG	8				
-12	SOC HD CAP SCREW	1/2-13 UNC-2A × 2.0 LONG	12				
-14	HEX CAP SCREW	3/4-10 UNC-2A × 2.0 LONG	4				
-17	LOCKWASHER	1/2	44				
-18	LOCKWASHER	3/4	4				
2011-1	STIFFENER FRAME		1				
-2	LEG WELDMENT		4				
-6	ANGLE	ASTM-A36 HFS -4.0×4.0×.25×225.0 LG	4				
-7	END PLATE	AISI 1020 HFS -.50×5.00×5.0 LG	8				
-3	BRACE	AISI 1020 HFS -.375 ×1.50×74.0 LG	14				
-4	BRACE	AISI 1020 HFS -.375×1.50×102.1 LG	11				
-9	HEX CAP SCREW	1/2-13 UNC-2A × 1.25 LONG	4				
-10	HEX CAP SCREW	1/2-13 UNC-2A × 1.75 LONG	29				
-11	HEX NUT	1/2-13 UNC-2B	29				
-12	LOCKWASHER	1/2	33				
2012-1	COLUMN ASSEMBLY		2				
-2	COLUMN WELDMENT		2				
-6	COLUMN	ASTM-A36 HFS - W8×67LB × 224.5 LG	2				
-7	END PLATE	ASTM-A36 HFS - .75 THICK × 8.0 × 8.0	4				
2013-1	GUIDE WELDMENT		4				
-5	BASE	AISI 1020 HFS -.75 × 4.00 × 98.75 LG	4				
-6	GUIDE	AISI 1020 HFS -1.75×3.50 × 98.75 LG	4				
-7	BEARING TAPE-GARLOCK	MULTIFIL № 426 -.030 × 1.00 × 99.0 LG	4				
2013-2	RETAINER BAR		6				
-9	BAR	AISI 1018 CFS -.75× 3.50 × 65.75	6				
-10	BEARING TAPE-GARLOCK	MULTIFIL № 426 -.030×1.00 × 66.0 LG	6				

PART NO. 2017
REV.
SH 4 OF 5

PRODUCTION CHART	WRITER Tallefson APR 27-83	PART NO. 2017	REV	SH 5 OF 5
TITLE FRACTURE TESTING MACHINE ASSEMBLY	CUSTOMER	P.O. NO. QUANTITY	JOB NO.	RELEASE DATE DUE DATE

NO.	PART NO.	DESCRIPTION	SPECIFICATIONS	UNIT QTY	JOB QTY	P.O. NO.	DATE	REC'D
	2017	FRACTURE TESTING MACHINE ASSY	CONTINUED	1				
	2012-1	COLUMN ASSEMBLY	CONTINUED	2				
3								
	-10	HEX CAP SCREW	1/2-13 UNC-2A × 2.25 LONG	36				
	-11	HEX CAP SCREW	5/8-11 UNC-2A x 3.5 LONG	18				
6	-12	HEX NUT	1/2-13 UNC-2B	36				
	-13	HEX NUT	5/8-11 UNC-2B	18				
8	-14	LOCKWASHER	1/2	36				
	-15	LOCKWASHER	5/8	18				
11								
	2014-1	BASE WELDMENT		1				
	-2	BOTTOM PLATE	ASTM-A36 HFS-1.00 THICK x 72.0 x 110.0	1				
14	-3	TOP PLATE	ASTM-A36 HFS-2.50 THICK × 72.0 × 102.0	1				
	-4	RIBS	ASTM-A36 HFS-1.50 THICK- SEE DRAWING					
			FOR SIZES					
17								
	2015	FOUNDATION	SEE DRAWING	1				
	2016-1	LINEAR TRANSDUCER INSTALL.		1				
	-2	BRACKET WELDMENT		1				
22	-5	ANGLE	ASTM-A36 HFS-2.0×2.0×.25×225.25 LG	1				
	-6	END BRACKET	AISI 1020 HFS-.38×2.50×5.5 LG	2				
25	-3	BRACKET	ASTM-A36 HFS-2.0×2.0×.25×4.0 LG	1				
28	-8	DIGITAL READOUT	MODEL 4051 EMP } QUALITY MEASUREMENT SYSTEMS	1				
	-9	TRANSDUCER	MODEL 1110-120"	1				
	-10	BACKER BAR	№ 153076-120"	1				
33	-13	RD HD SCREW	№ 6-32 UNC-2A ×.75 LONG	4				
	-14	SOC SET SCREW	1/4-20 UNC-2A × .50 LONG					
	-15	HEX CAP SCREW	3/8-16 UNC-2A × 1.0 LONG	6				
36	-16	SOC HD CAP SCREW	1/4-20 UNC-2A × .75 LONG					
	-17	SOC HD CAP SCREW	1/4-20 UNC-2A ×1.0 LONG	11				
39	-19	LOCKWASHER	№ 6	4				
	-20	LOCKWASHER	3/8	6				
42	-22	HEX NUT	№ 6-32 UNC-2B	4				
44	2019	TUP & ANVIL INSTALLATION	SEE SEPARATE PRODUCTION CHART	1				
	2017-12	SHOCK ABSORBER-MODEL 4×8	TAYLOR DEVICES № 67SS-12583-010	2				
47	2017-15	HEX CAP SCREW	3/4-10 UNC-2A × 2.0 LONG	20				
	-16	HEX CAP SCREW	1-8 UNC-2A × 4.0 LONG	4				
	-20	LOCKWASHER	3/4	20				
50								

PART NO.	REV.	SH.
2017		5 OF 5

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

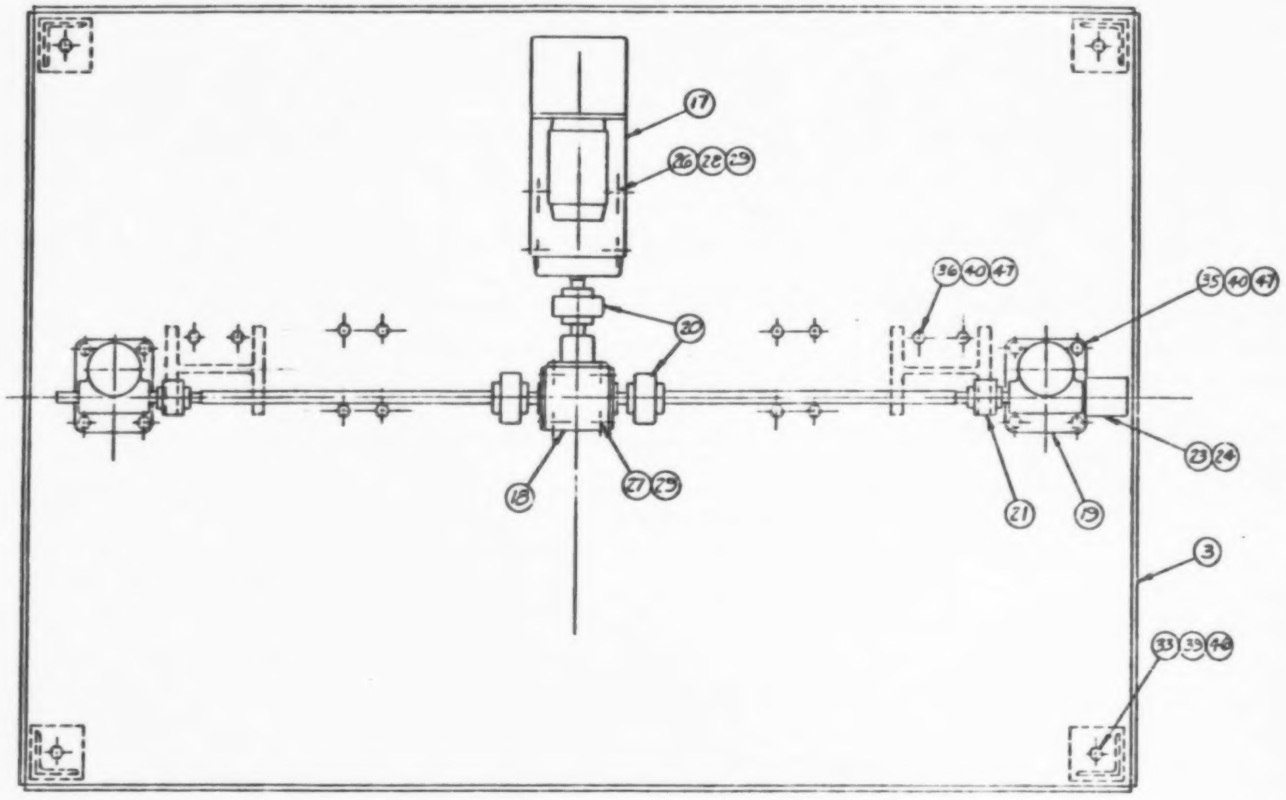
(UPGRADEABLE TO 112 KJ)

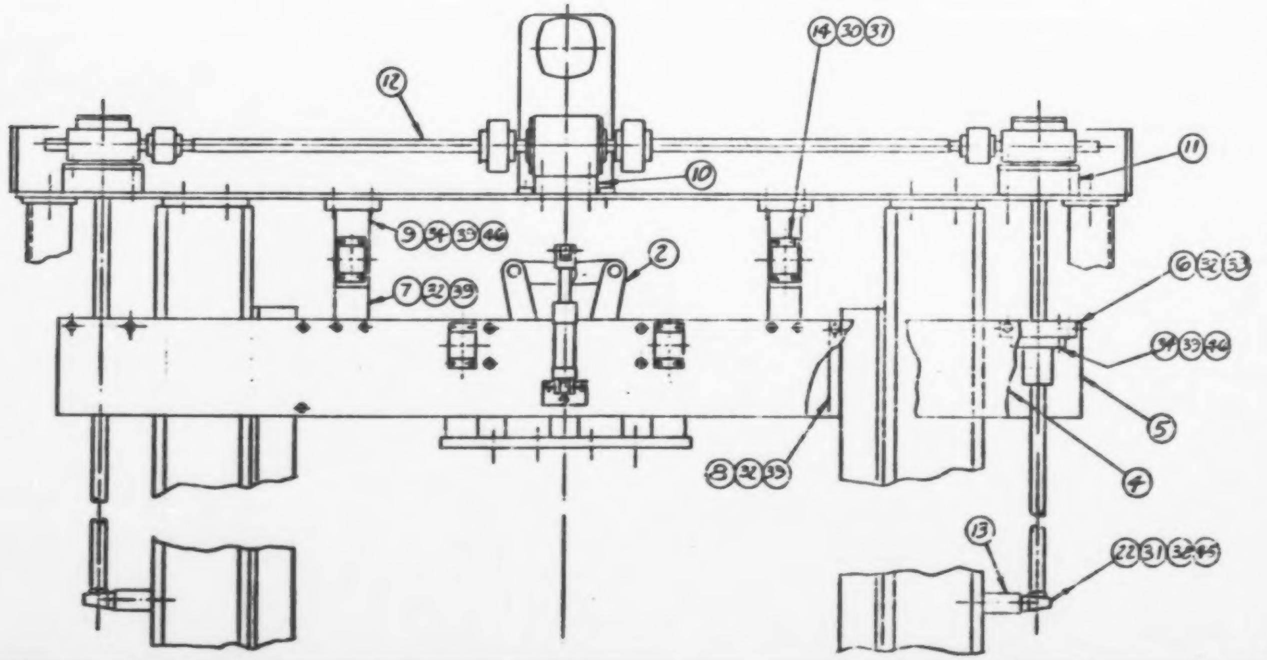
DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

PRODUCTION CHART	WRITER [illegible]	PART NO. 2019	REV.	SH OF	TITLE INSTALLATION TUP AND ANVIL	CUSTOMER	P.O. NO.	QUANTITY	HYDRANAUTICS JOB NO.	RELEASE DATE	DUE DATE

NO.	PART NO	DESCRIPTION	SPECIFICATIONS	UNIT QTY	JOB QTY	P.O. NO.	DATE		REC'D	
1	2019	INSTALLATION-TUP & ANVIL		1						
2	2020-2	ANVIL BASE WELDMENT		2						
3	-14	BASE	ASTM-A36 HFS-1.50 THICK × 14.0 × 16.0	2						
4	-15	VERTICAL	ASTM-A36 HFS-5.00 THICK × 8.0 × 11.0	2						
5	-16	GUSSET	ASTM-A36 HFS-1.50 THICK × 4.0 × 9.5	4						
6	-17	GUSSET	ASTM-A36 HFS-1.50 THICK × 7.5 × 9.5	2						
7										
8										
9	2020-3	TUP BASE WELDMENT		1						
10	-19	BASE	ASTM-A36 HFS-2.00 THICK × 7.5 × 11.0	1						
11	-20	VERTICAL	AISI 1020 HFS-2.00 THICK × 5.0 × 14.0	1						
12	-21	GUSSET	ASTM-A36 HFS-1.50 THICK × 2.75 × 5.0	2						
13										
14										
15	2020-4	BASE PLATE	ASTM-A36 HFS-2.00 THICK × 20.0 × 68.0	1						
16										
17	2020-5	ANVIL INSERT 12.7 R	TOOL STEEL-AISI-02-1.5 THICK × 5.0 × 8.0	2						
18	2020-6	ANVIL INSERT 20 R	TOOL STEEL-AISI-02-1.5 THICK × 5.0 × 8.0	2						
19	2020-7	ANVIL INSERT 30 R	TOOL STEEL-AISI-02-1.5 THICK × 5.0 × 8.0	2						
20										
21	2020-9	TUP INSERT 12.7 R	TOOL STEEL AISI-02-2.0 THICK × 2.0 × 5.0	1						
22	2020-10	TUP INSERT 20 R	TOOL STEEL AISI-02-2.0 THICK × 2.0 × 5.0	1						
23	2020-11	TUP INSERT 30 R	TOOL STEEL AISI-02-2.0 THICK × 2.0 × 5.0	1						
24										
25	2019-13	KEY	AISI 1018 CFS -.75 SQUARE × 3.0 LG	2						
26										
27										
28	-15	SOC HD CAP SCREW	1/2-13UNC-2A × 1.5 LG	10						
29										
30										
31	-18	HEX CAP SCREW	3/4-10UNC-2A × 3.0 LG	24						
32										
33										
34	-21	LOCKWASHER	3/4	24						

PART NO.	REV.	SH OF
2019		





65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

2. BALL SCREW JACK TO HAVE SCREW 144" LONG

1. MANNESMANN DEMAG: MAIN MOTOR Nº KB 112 MA
(10:1) INTERMEDIATE GEAR BOX Nº FG 08
MICROMOTOR Nº KB71A

NOTES:

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	50			
	49			
	48			
16	47		HEX NUT	3/4"-10 UNC-2B
44	46		HEX NUT	1/2"-13 UNC-2B
4	45		HEX NUT	3/8"-16 UNC-2B
	44			
	43			
4	42		FLATWASHER	3/8"
	41			
16	40		LOCKWASHER	3/4"
44	39		LOCKWASHER	1/2"
4	38		LOCKWASHER	3/8"
8	37		LOCKWASHER	5/16"
8	36		HEX CAP SCREW	3/4"-10 UNC-2A x 2.50" LONG
8	35		HEX CAP SCREW	3/4"-10 UNC-2A x 3.75" LONG
16	34		HEX CAP SCREW	1/2"-13 UNC-2A x 2.25" LONG
12	33		HEX CAP SCREW	1/2"-13 UNC-2A x 2.0" LONG
24	32		HEX CAP SCREW	1/2"-13 UNC-2A x 1.25" LONG
4	31		HEX CAP SCREW	3/8"-16 UNC-2A x 6.0" LONG
8	30		HEX CAP SCREW	5/16"-18 UNC-2A x 1.0" LONG
8	29		LOCKWASHER	M12
4	28		HEX NUT	M12
4	27		HEX CAP SCREW	M12 x 70 MM LONG
4	26		HEX CAP SCREW	M12 x 45 MM LONG
	25			
1	24		POSITION TRANSDUCER	DUFF NORTON Nº SK-6200-T-40
1	23		LIMIT SWITCH	DUFF NORTON Nº SK-6000-C-40
2	22		PILLOW BLOCK	DODGE Nº SC-1" SHAFT
2	21		BALL SCREW COUPLING	DUFF NORTON Nº SK-2403
3	20		MOTOR COUPLING	DEMAG Nº H2N-2B
2	19	SEE NOTE 2.	BALL SCREW JACK	DUFF-NORTON Nº DM-2811
1	18		BEVEL GEAR BOX	HUB CITY MODEL 228 -1:1 GEAR RATIO
1	17		DRIVE MOTOR	SEE NOTE 1.
	16			
	15			
2	14	2006-2	LOCK CYLINDER	
2	13	2007-11	SPACER-PILLOW BLOCK	
2	12	2007-12	DRIVE SHAFT	
4	11	2007-10	SPACER BLOCK	
2	10	2007-9	SPACER BLOCK	
2	9	2008-6	CYLINDER BRACKET	
2	8	2008-5	GUIDE WELDMENT	
2	7	2008-4	LOCK BRACKET WELD.	
2	6	2008-3	NUT PLATE	
1	5	2008-2	CROSSHEAD PLATE -REAR	
1	4	2008-1	CROSSHEAD PLATE -FRONT	
1	3	2007-2	PLATFORM	
1	2	2002	INSTALLATION LATCH MECH	
	1	2001	HOISTING MECHANISM	

LIST OF MATERIAL

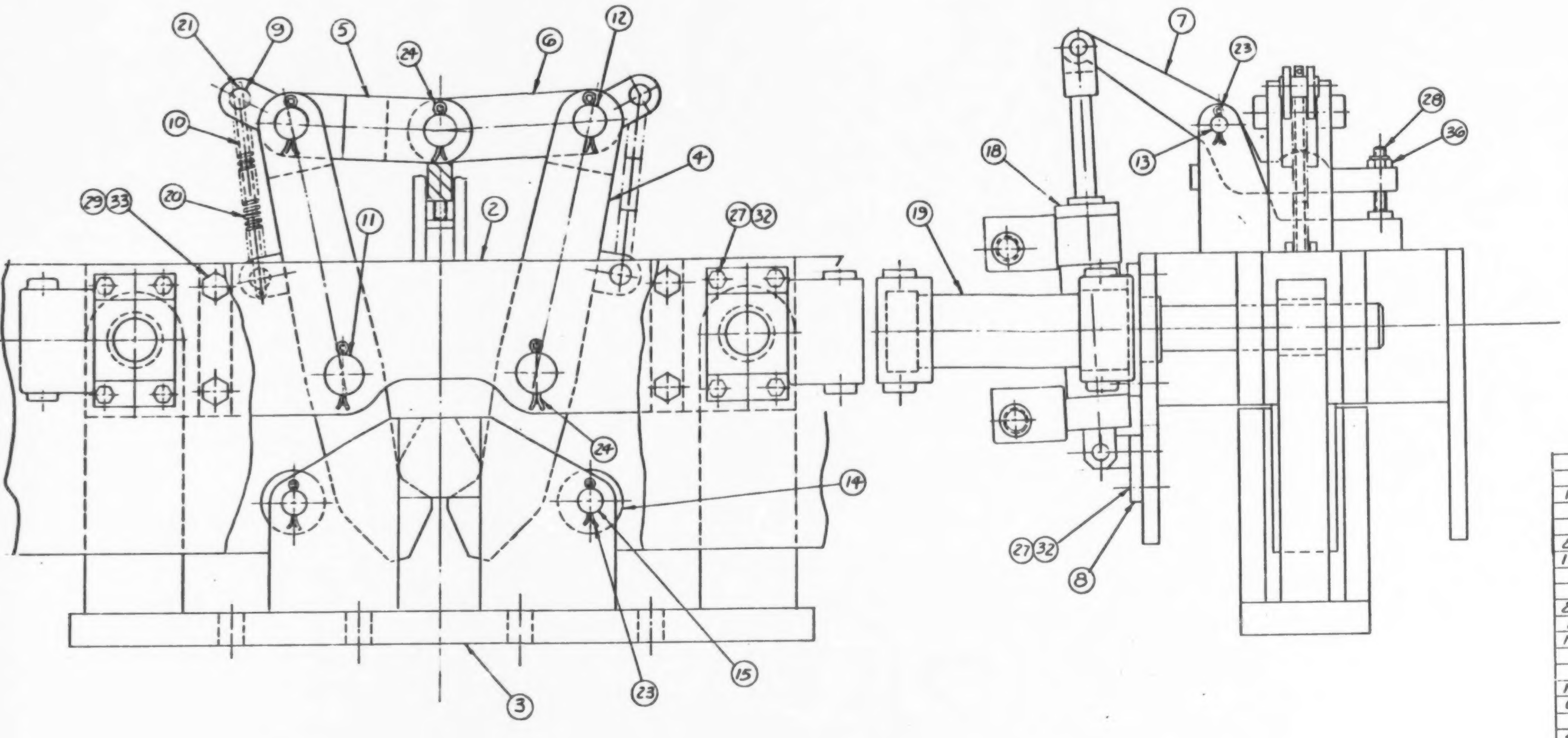
TOLERANCES ON			
1 PLACE DEC.	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS PER MIL-STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015 R.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .015 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .001 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
HOISTING MECHANISM

DRAWN FEB 24-83 T.S.No.Hon
CHECKED
SCALE EIGHTH
DRAWING NO. 2001
REV
WEIGHT
OF



QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	38			
	37			
1	36		HEX NUT-SELFLOCKING	3/8"-16 UNC-2B
	35			
	34			
8	33		LOCKWASHER	1/2"
11	32		LOCKWASHER	5/16"
	31			
	30			
8	29		HEX CAP SCREW	1/2"-13 UNC-2A x 1.25" LONG
1	28		SOC SET SCREW-CUP PT.	3/8"-16UNC-2A x 2.0" LONG
11	27		HEX CAP SCREW	5/16"-18 UNC-2A x 1.0" LONG
	26			
	25			
10	24		COTTER PIN	3/16" DIA x 1.75" LONG
6	23		COTTER PIN	1/8" DIA x 1.0" LONG
	22			
4	21		SPRING PIN	.094" DIA x .62" LONG
6	20	SEE NOTE 1.	SPRING	LEE № LC-047F-9
2	19	2006-1	LOCK CYLINDER	
1	18	2006-3	LATCH TRIP CYLINDER	
	17			
	16			
2	15	2004-4	ROLLER SHAFT	
2	14	2004-3	ROLLER	
1	13	2005-8	PIVOT PIN-TRIPLEVER	
3	12	2005-7	PIVOT PIN-TOGGLE	
2	11	2005-6	PIVOT PIN-LATCH	
2	10	2005-5	SPRING ROD	
4	9	2005-4	SPRING PIVOT SHAFT	
1	8	2004-2	CYLINDER BRACKET	
1	7	2005-9	TRIP LEVER	
1	6	2005-3	TOGGLE LEVER-R.H.	
1	5	2005-2	TOGGLE LEVER-L.H.	
2	4	2005-1	LATCH LEVER	
1	3	2004-1	LATCH HOOK	
1	2	2003	LATCH FRAME	
	1	2002	INSTALLATION	

LIST OF MATERIAL

TOLERANCES ON

1 PLACE DEC	2 PLACE DEC	3 PLACE DEC	ANGLES
±.1	±.03	±.010	±0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS PER MIL STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.020.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .003 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE INSTALLATION
LATCH MECHANISM AND
LOCK CYLINDERS

DRAWN FEB 15-83 Tellefsen
CHECKED
SCALE HALF
DRAWING NO. 2002
REV
WEIGHT
OF

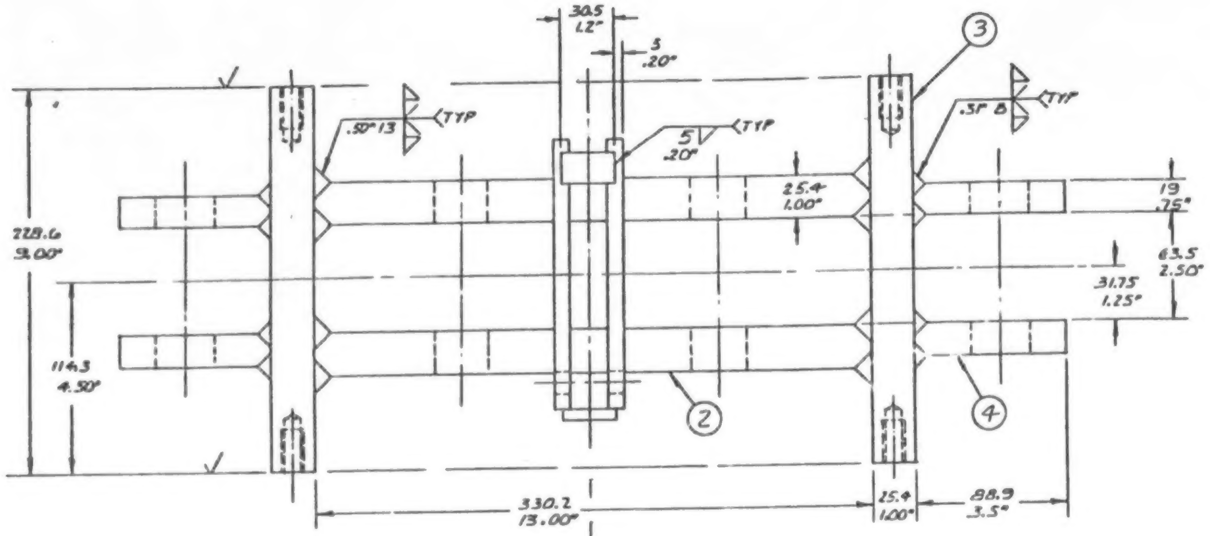
65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

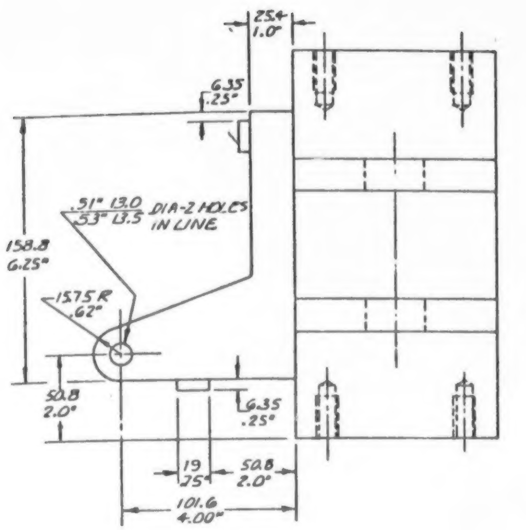
(UPGRADEABLE TO 112 KJ)

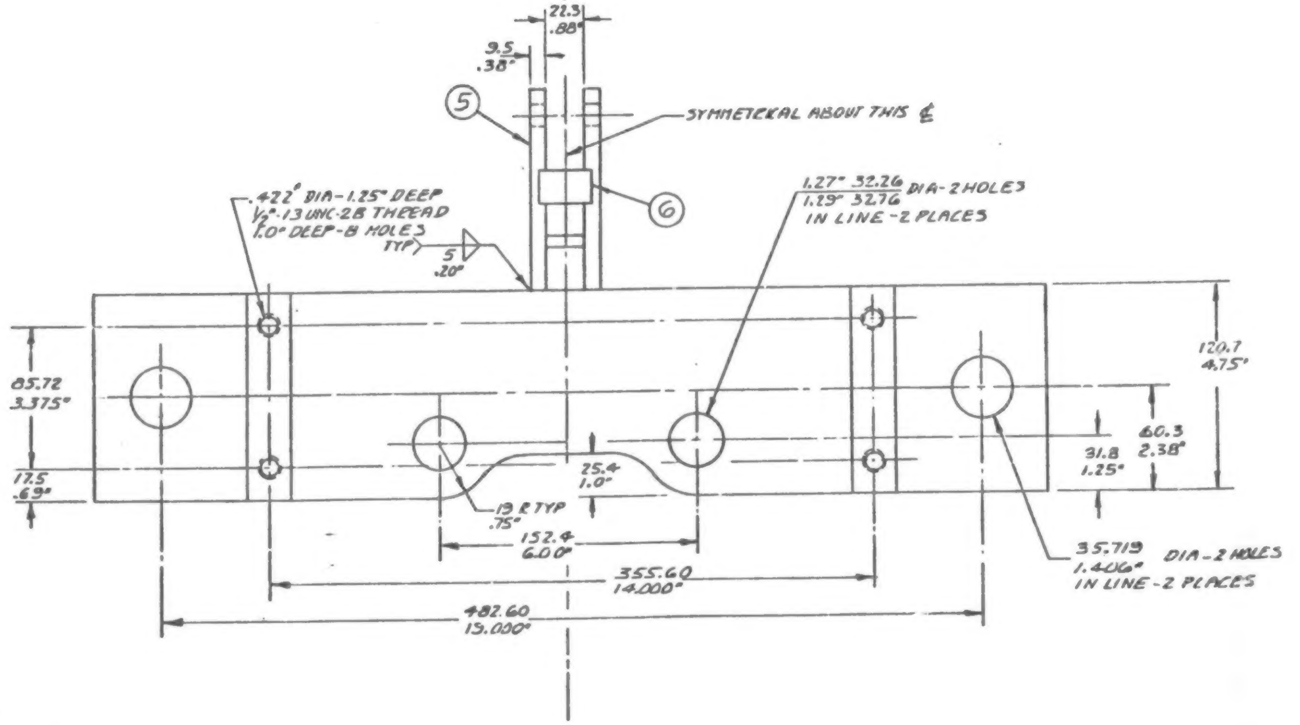
DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

1. LEE SPRING CO. - 30 MAIN ST. BROOKLYN N.Y. 11201

NOTES:


30.5
1.2"
3
.20"
③
.50" 13
TYP
5
.20"
TYP
.31" 8
TYP
25.4
1.00"
19
.75"
63.5
2.50"
31.75
1.25"
228.6
9.00"
114.3
4.50"
②
④
330.2
13.00"
25.4
1.00"
88.9
3.5"


25.4
1.0"
6.35
.25"
.51" 13.0
.53" 13.5 DIA-2 HOLES IN LINE
158.8
6.25"
15.75 R
.62"
50.8
2.0"
6.35
.25"
19
.75"
50.8
2.0"
101.6
4.00"


22.3
.88"
9.5
.38"
⑤
SYMMETRICAL ABOUT THIS ℄
⑥
.422" DIA-1.25" DEEP
1/2"-13 UNC-2B THREAD
1.0" DEEP-8 HOLES
TYP
5
.20"
1.27" 32.26
1.29" 32.76 DIA-2 HOLES
IN LINE-2 PLACES
120.7
4.75"
85.72
3.375"
17.5
.69"
25.4
1.0"
13 R TYP
.75"
31.8
1.25"
60.3
2.38"
152.4
6.00"
355.60
14.000"
482.60
19.000"
35.719
1.406" DIA-2 HOLES
IN LINE-2 PLACES

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	10			
	9			
	8			
	7			
2	6		BAR	AISI 1020 HFS -.25" x .75"
2	5		EAR	ASTM-A36 HFS -.375" THICK
4	4		PLATE	ASTM-A36 HFS -.75" THICK
2	3		PLATE	ASTM-A36 HFS -1.00" THICK
2	2		PLATE	ASTM-A36 HFS -1.00" THICK
	1	2003	LATCH FRAME WELDMENT	

LIST OF MATERIAL

TOLERANCES ON

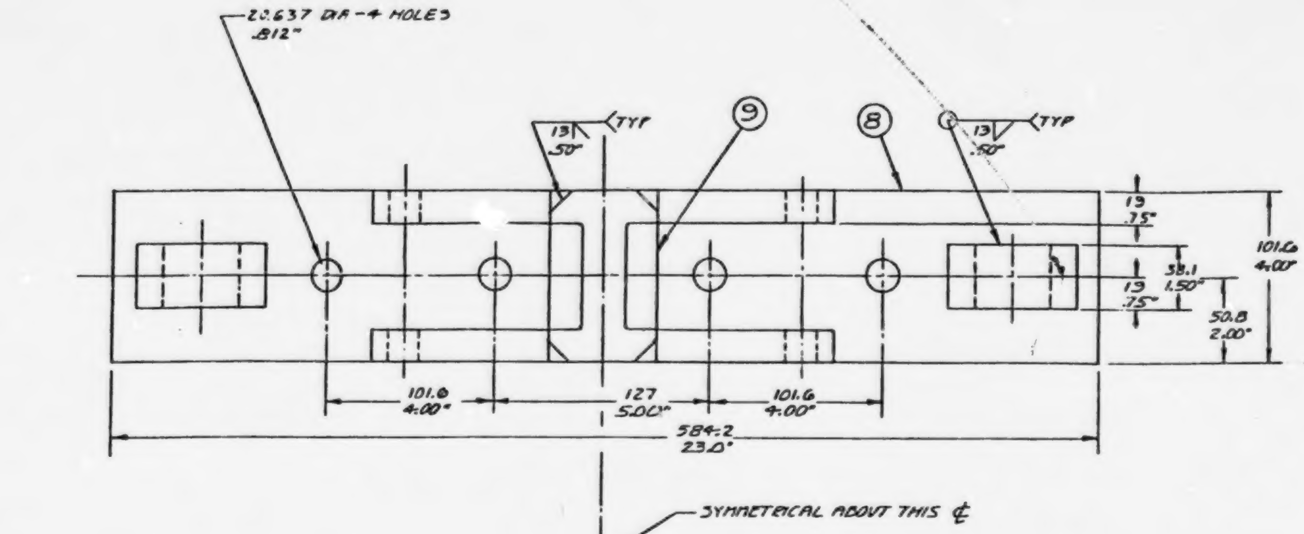
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC	ANGLES
± .1	± .03	± .010	± 0°-30'

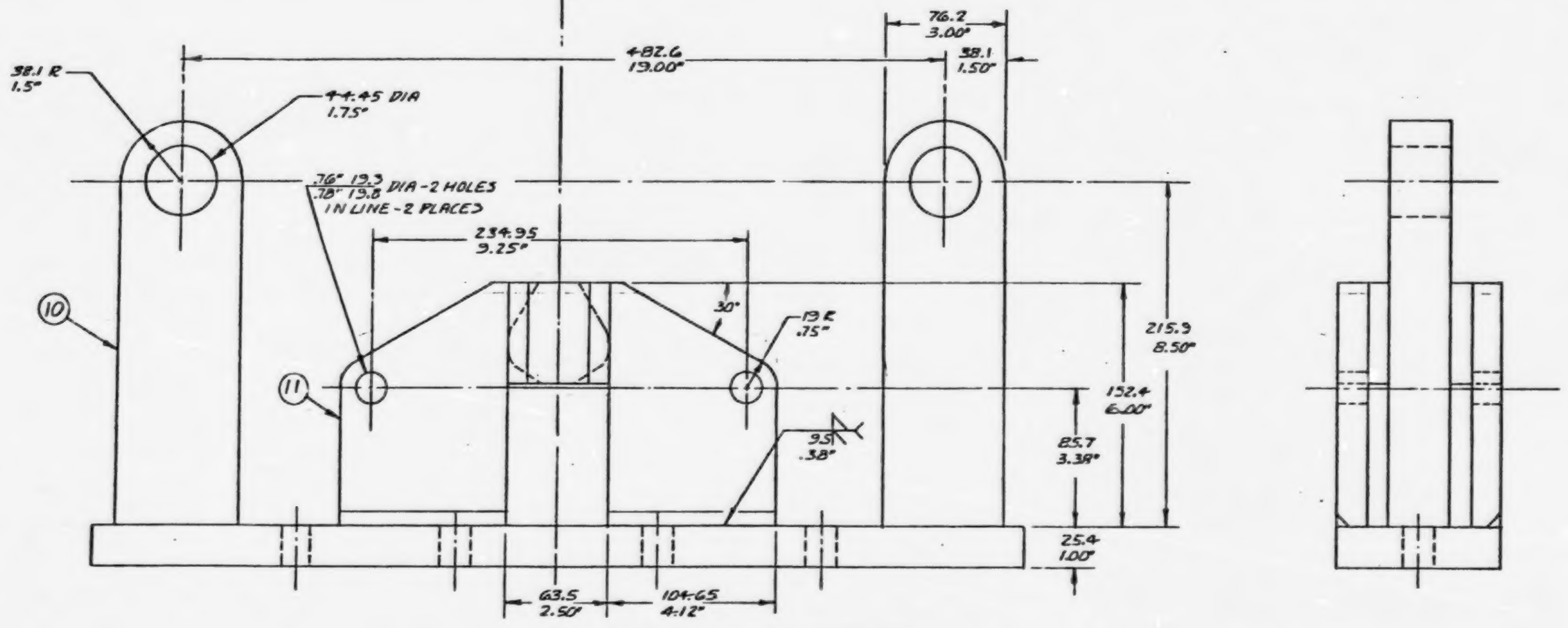
1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .006 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

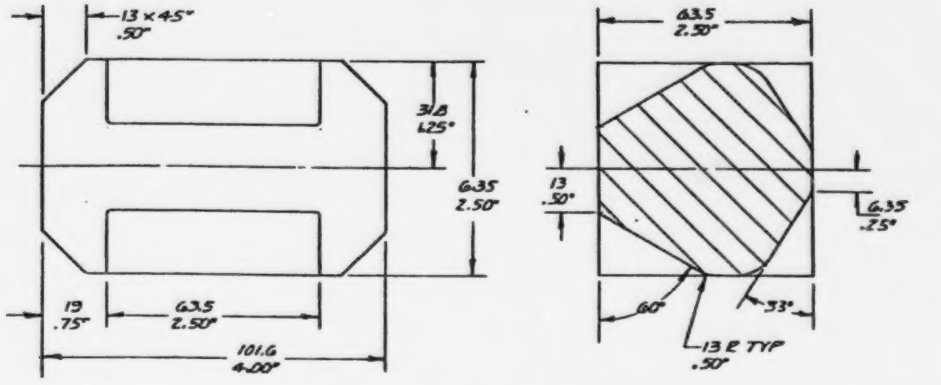
TITLE LATCH FRAME WELDMENT

DRAWN 4812-23 Tellefsen
CHECKED
SCALE HALF
DRAWING NO. 2003
REV
WEIGHT
OF

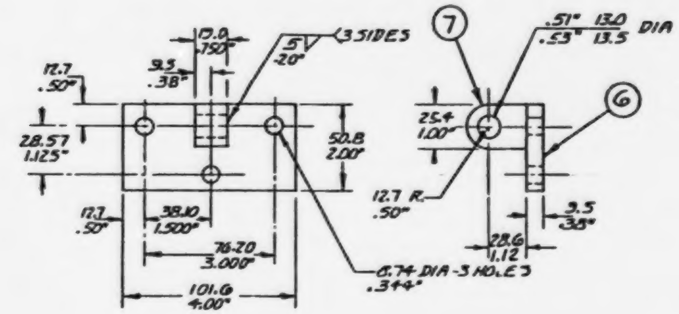

20.637 DIA-4 HOLES
.812"
13 .50" TYP
9
8
13 .50" TYP
19 .75"
38.1 1.50"
19 .75"
101.6 4.00"
50.8 2.00"
101.6 4.00"
127 5.00"
101.6 4.00"
584.2 23.0"
SYMMETRICAL ABOUT THIS ℄


38.1 R 1.5"
44.45 DIA 1.75"
482.6 19.00"
76.2 3.00"
38.1 1.50"
.76" 19.3
.78" 19.8 DIA-2 HOLES
IN LINE-2 PLACES
234.95 9.25"
30°
19 R .75"
10
11
9.5 .38"
215.9 8.50"
152.4 6.00"
85.7 3.38"
25.4 1.00"
63.5 2.50"
104.65 4.12"

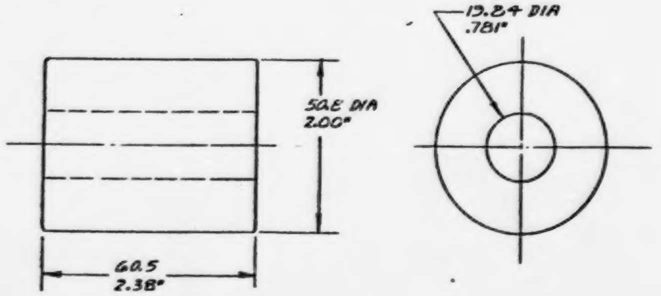
① LATCH HOOK WELDMENT


13 × 45° .50"
31.8 1.25"
63.5 2.50"
63.5 2.50"
13 .50"
6.35 .25"
19 .75"
63.5 2.50"
101.6 4.00"
60°
33°
13 R TYP .50"

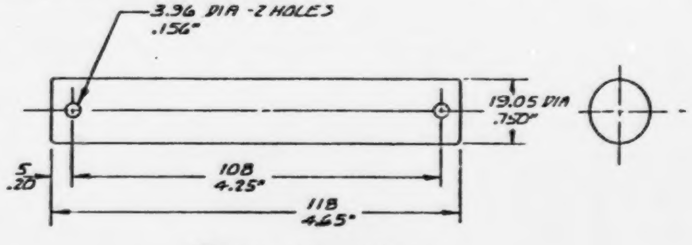
⑨ LATCH BLOCK
SCALE-FULL


12.7 .50"
9.5 .38"
19.0 .750"
5 .20" 3 SIDES
7
.51" 13.0
.53" 13.5 DIA
6
28.57 1.125"
50.8 2.00"
25.4 1.00"
12.7 R .50"
12.7 .50"
38.10 1.500"
76.20 3.000"
101.6 4.00"
8.74 DIA-3 HOLES .344"
28.6 1.12
9.5 .38"

② CYLINDER BRACKET


19.84 DIA .781"
50.8 DIA 2.00"
60.5 2.38"

③ ROLLER
SCALE-FULL


3.96 DIA-2 HOLES .156"
19.05 DIA .750"
5 .20
108 4.25"
118 4.65"

④ ROLLER SHAFT
SCALE-FULL

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00219
CANMET PROJECT NUMBER	:	420604

QTY -2	QTY -1	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
		12			
	4	11		SIDE PLATE	ASTM-A36 HFS-.75" THICK
	2	10		BLADE	AISI 1020 HFS-1.50" x 3.00"
	1	9		LATCH BLOCK	AISI 1020 HFS-2.50" SQUARE
	1	8		BASE	AISI 1020 HFS-1.00" x 4.00"
1		7		EAR	AISI 1018 CFS-.75" x 1.00"
1		6		BASE	AISI 1020 HFS-.38" x 2.00"
		5			
		4	2004-4	ROLLER SHAFT	STN. STL.-TYPE 304 C.F.-.750 DIA
		3	2004-3	ROLLER	AISI 1018 CFS-2.00" DIA
~		2	2004-2	CYLINDER BRKT WELD.	
	~	1	2004-1	LATCH HOOK WELDMENT	

LIST OF MATERIAL

TOLERANCES ON

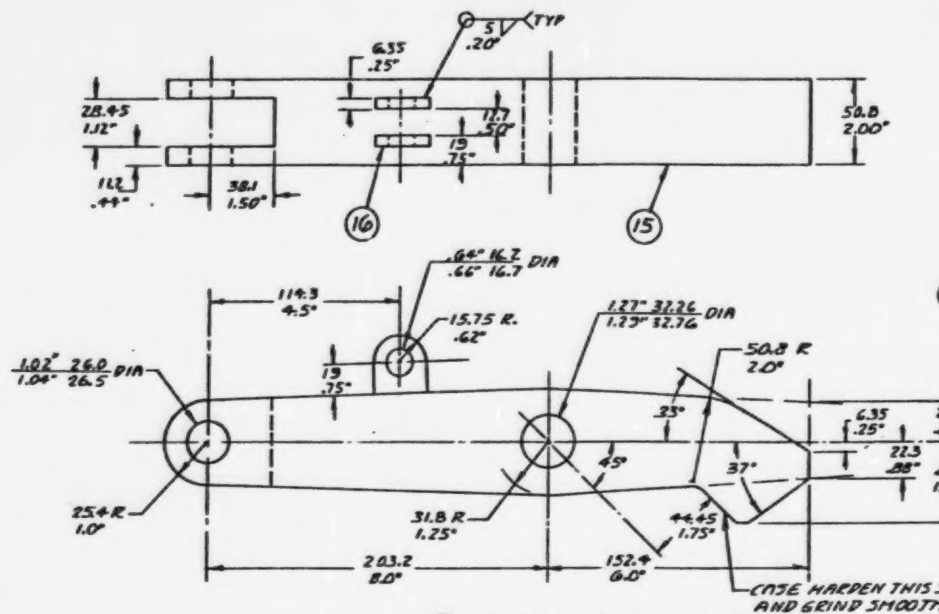
1 PLACE DEC.	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .001 PER INCH, TO A MAX. OF .002 INCHES FOR A SINGLE SURFACE.

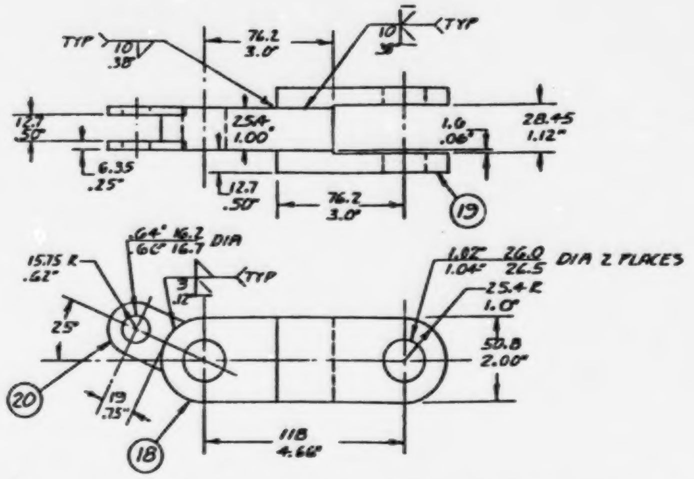
SASKATCHEWAN RESEARCH COUNCIL
SASKATOON, SASKATCHEWAN

TITLE
LATCH HOOK DETAILS

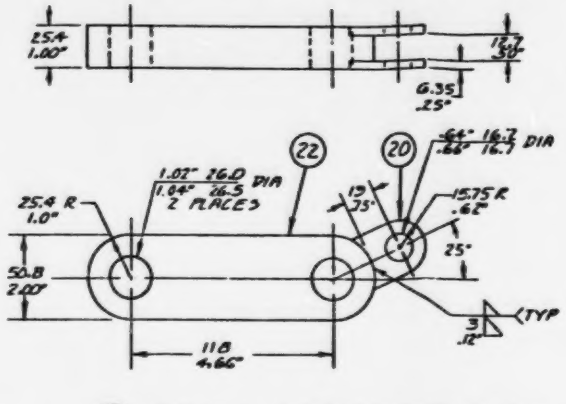
DRAWN FEB 13-83 Tellefsen
CHECKED
SCALE HALF & NOTED
DRAWING NO. 2004
REV
WEIGHT 71.5 LBS
OF


6.35
.25"
.20"
TYP
28.45
1.12"
12.7
.50"
19
.75"
11.2
.44"
38.1
1.50"
50.8
2.00"
16
15
.64" 16.7
.66" 16.7 DIA
114.3
4.5"
15.75 R.
.62"
1.27" 32.26
1.29" 32.76 DIA
50.8 R
2.0"
1.02" 26.0
1.04" 26.5 DIA
19
.75"
.25"
45°
37°
6.35
.25"
22.3
.88"
47.8
1.88"
25.4 R
1.0"
31.8 R
1.25"
44.45
1.75"
203.2
8.0"
152.4
6.0"
CASE HARDEN THIS SURFACE AND GRIND SMOOTH

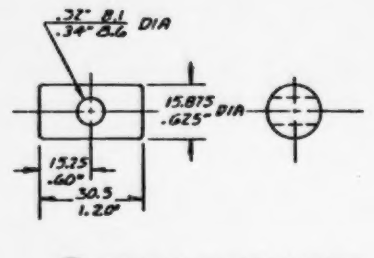
① LATCH LEVER WELDMENT


TYP
10
.38
76.2
3.0"
10
.38
TYP
12.7
.50"
25.4
1.00"
1.6
.06"
28.45
1.12"
6.35
.25"
12.7
.50"
76.2
3.0"
19
15.75 R
.62"
.64" 16.2
.66" 16.7 DIA
3
.12
TYP
1.02" 26.0 DIA 2 PLACES
1.04" 26.5
25.4 R
1.0"
25°
50.8
2.00"
20
19
.75"
18
118
4.66"

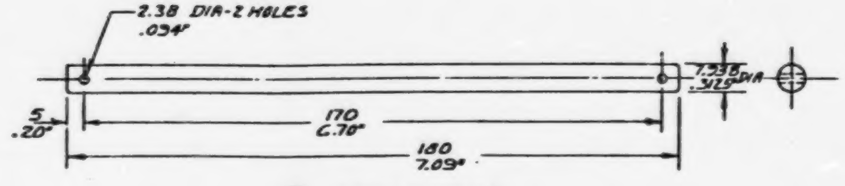
② TOGGLE LEVER WELDMENT-LH


25.4
1.00"
12.7
.50"
6.35
.25"
22
20
.64" 16.2 DIA
.66" 16.7
1.02" 26.0 DIA
1.04" 26.5
2 PLACES
25.4 R
1.0"
19
.75"
15.75 R
.62"
25°
50.8
2.00"
3
.12
TYP
118
4.66"

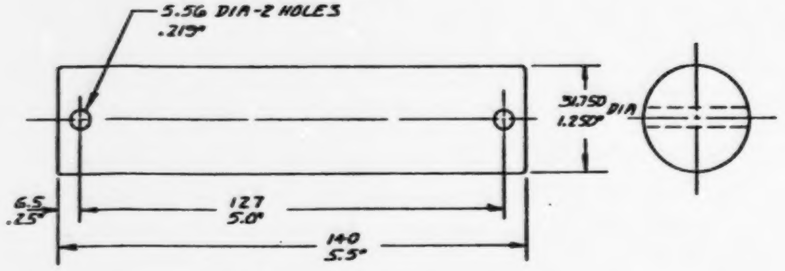
③ TOGGLE LEVER WELDMENT-RH


.32" 8.1
.34" 8.6 DIA
15.875
.625" DIA
15.25
.60"
30.5
1.20"

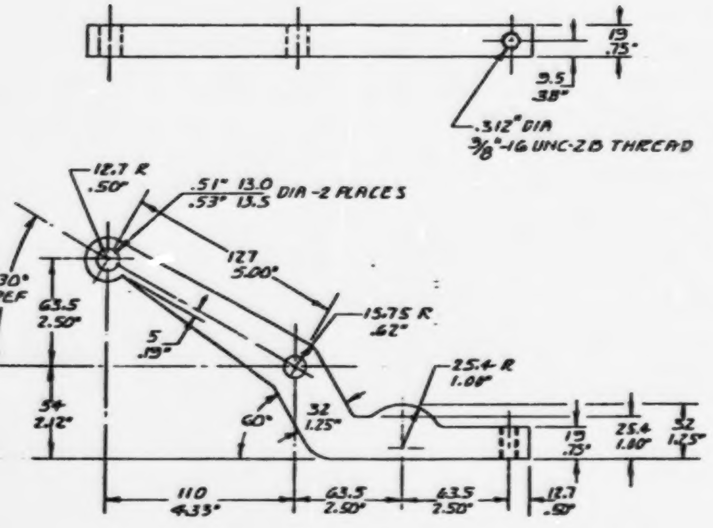
④ SPRING PIVOT SHAFT
SCALE-FULL


2.38 DIA-2 HOLES
.094"
7.938
.3125 DIA
5
.20"
170
6.70"
180
7.09"

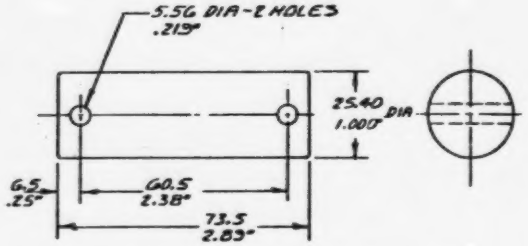
⑤ SPRING ROD
SCALE-FULL


5.56 DIA-2 HOLES
.219"
31.750
1.250" DIA
6.5
.25
127
5.0"
140
5.5"

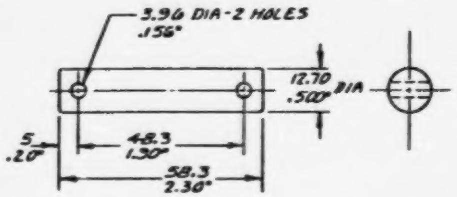
⑥ PIVOT PIN-LATCH LEVER
SCALE-FULL


19
.75"
9.5
.38"
.312" DIA
3/8"-16 UNC-2B THREAD
12.7 R
.50"
.51" 13.0
.53" 13.5 DIA-2 PLACES
127
5.00"
30°
REF
63.5
2.50"
5
.19"
15.75 R
.62"
25.4 R
1.00"
54
2.12"
60°
32
1.25"
19
.75"
25.4
1.00"
32
1.25"
110
4.33"
63.5
2.50"
63.5
2.50"
12.7
.50"

⑨ TRIP LEVER


5.56 DIA-2 HOLES
.219"
25.40
1.000" DIA
6.5
.25"
60.5
2.38"
73.5
2.89"

⑦ PIVOT PIN-TOGGLE LEVER
SCALE-FULL


3.96 DIA-2 HOLES
.156"
12.70
.500" DIA
5
.20
48.3
1.90"
58.3
2.30"

⑧ PIVOT SHAFT-TRIP LEVER
SCALE-FULL

			24			
			23			
1			22		ARM	AISI 1020 HFS-1.00"x2.00"
			21			
2	2		20		EAR	AISI 1020 HFS-.25"x1.25"
	2		19		CLEVIS PLATE	AISI 1020 HFS-.50"x2.00"
	1		18		ARM	AISI 1020 HFS - 1.00"x2.00"
			17			
		2	16		EAR	AISI 1020 HFS -.25"x1.25"
		1	15		LATCH LEVER	ASTM-A36 HFS-2.00"THICK
			14			
			13			
			12			
			11			
			10			
			9		TRIP LEVER	ASTM-A36 HFS-.75"THICK
			8		PIVOT PIN-TRIP LEVER	STN.STL.-TYPE 304 CF-.500"DIA
			7		PIVOT PIN-TOGGLE LEVER	STN.STL.-TYPE 304 CF-1.000"DIA
			6		PIVOT PIN-LATCH LEVER	STN.STL.-TYPE 304 CF-1.250"DIA
			5		SPRING ROD	STN.STL.-TYPE 304 CF-.3125"DIA
			4		SPRING PIVOT SHAFT	STN.STL.-TYPE 304 CF-.625"DIA
~			3	2005-3	TOGGLE LEVER WELD-R.H.	
	~		2	2005-2	TOGGLE LEVER WELD-L.H.	
		~	1	2005-1	LATCH LEVER WELDMENT	
-3	-2	-1	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
		QTY	LIST OF MATERIAL			

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00219
CANMET PROJECT NUMBER	:	420604

TOLERANCES ON

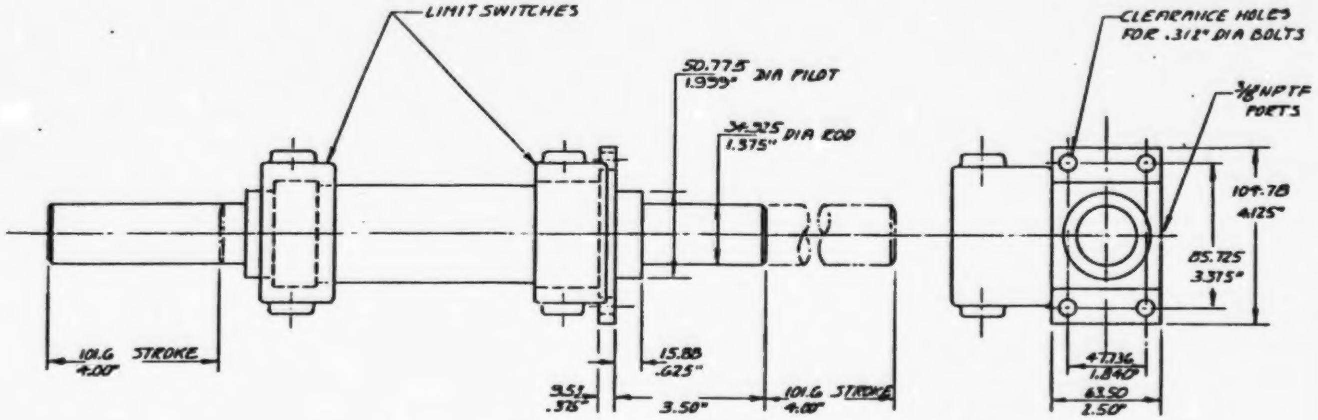
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC	ANGLES
±.1	±.03	±.010	±0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS PER MIL-STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .010-.020.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

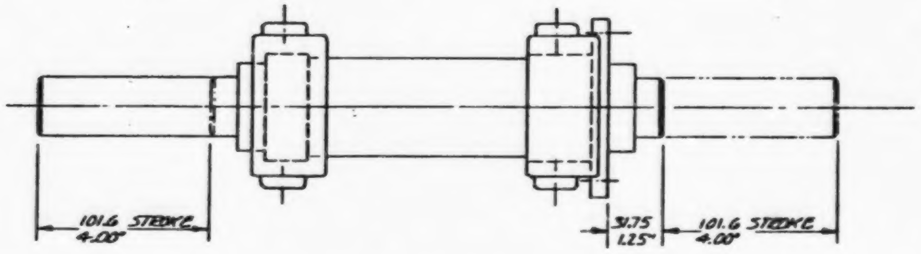
TITLE
LATCH DETAILS

DRAWN Tillefse.
CHECKED
SCALE HALF & NOTED
DRAWING NO. 2005
REV
WEIGHT
OF


LIMIT SWITCHES
50.775 / 1.999" DIA PILOT
34.925 / 1.375" DIA ROD
CLEARANCE HOLES FOR .312" DIA BOLTS
3/8 NPTF PORTS
109.78 / 4.125"
85.725 / 3.375"
101.6 / 4.00" STROKE
15.88 / .625"
9.51 / .375"
3.50"
101.6 / 4.00" STROKE
47.736 / 1.840"
63.50 / 2.50"

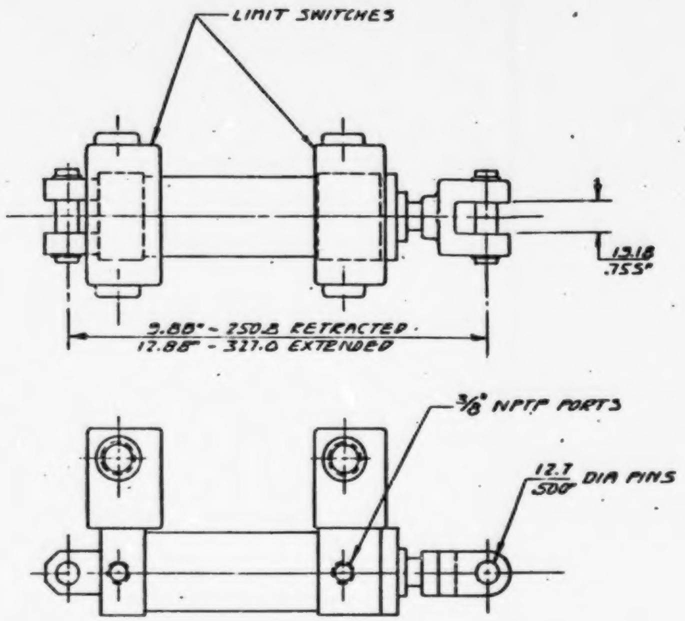
① LOCK CYLINDER-LATCH MECHANISM

TOMKINS-JOHNSON SQUAIR SERIES
MODEL S-2 FLANGE MOUNT
BORE - 2.00" - 50.8
DOUBLE END ROD DIA - 1.375" - 34.925
STROKE - 4.00" - 101.6
LIMIT SWITCH BOTH ENDS
CUSHION BOTH ENDS


101.6 / 4.00" STROKE
31.75 / 1.25"
101.6 / 4.00" STROKE

② LOCK CYLINDER - CROSSHEAD

DIMENSIONS AND SPECIFICATIONS NOT
SHOWN ARE SAME AS CYLINDER ABOVE


LIMIT SWITCHES
13.18 / .755"
9.88" - 250.8 RETRACTED
12.88" - 327.0 EXTENDED
3/8" NPTF PORTS
12.7 / .500" DIA PINS

③ LATCH TRIP CYLINDER

TOMKINS-JOHNSON SQUAIR SERIES
MODEL S-3 CLEVIS MOUNT
BORE 2.00" - 50.8
ROD DIA .625" - 15.88
STROKE 3.0" - 76.2
LIMIT SWITCH BOTH ENDS
CUSHION BOTH ENDS
WITH ROD CLEVIS PART Nº S-1-562

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

NOTES:

1. THE TOMKINS-JOHNSON CO.
2425 WEST MICHIGAN AVE
JACKSON, MICHIGAN 49202

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	10			
	9			
	8			
	7			
	6			
	5			
	4			
	3	2006-3	LATCH TRIP CYLINDER	
	2	2006-2	LOCK CYLINDER	CROSSHEAD
	1	2006-1	LOCK CYLINDER	LATCH MECHANISM

LIST OF MATERIAL

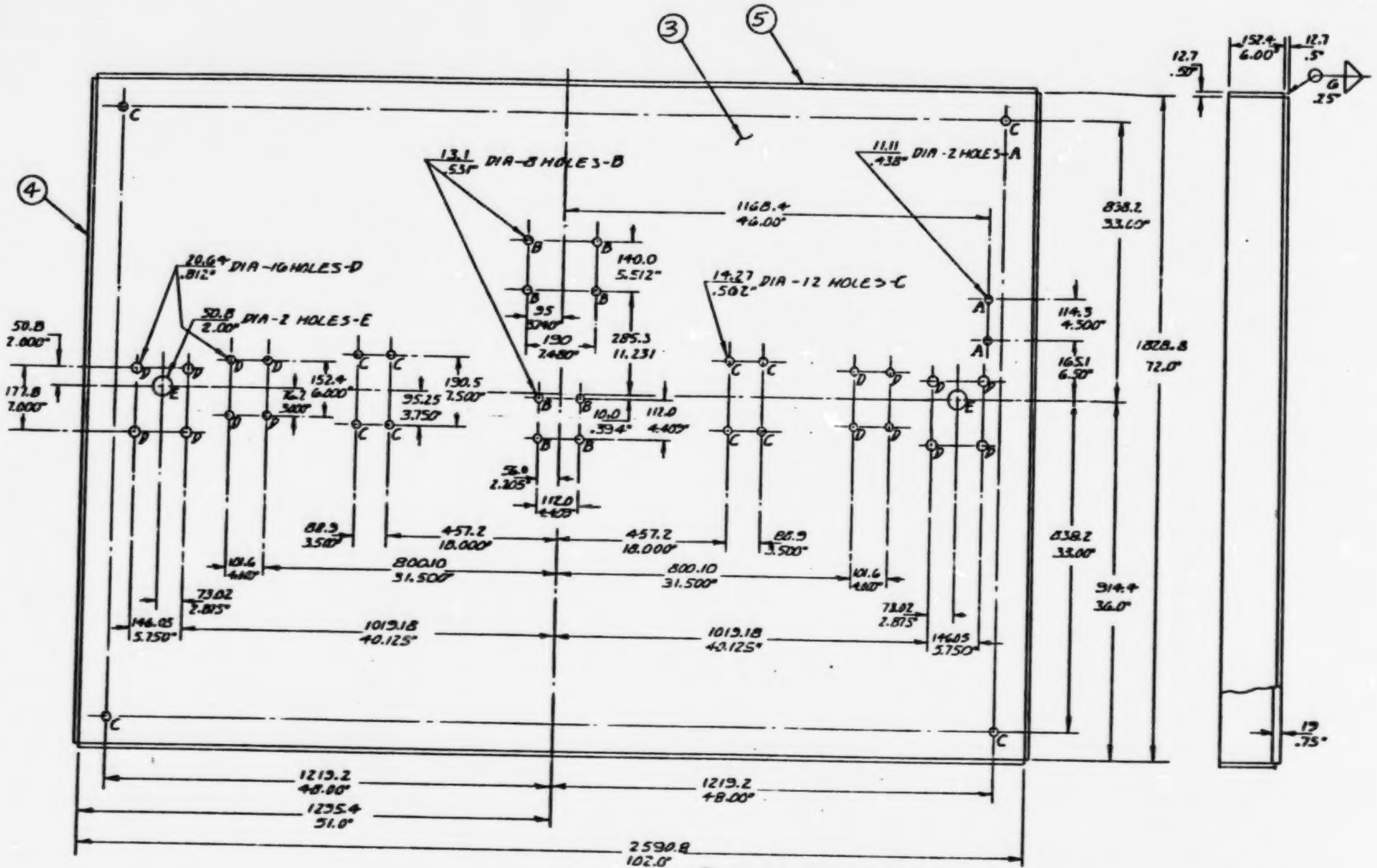
TOLERANCES ON			
1 PLACE DEC.	2 PLACE DEC	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0° 30'

1 DIMENSIONS ARE IN INCHES.
2 REMOVE BURRS AND SHARP EDGES .015 MAX.
3 ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4 DIMENSION LIMITS HELD AFTER PLATING.
5 MACHINED FILLET RADII .015-.030.
6 MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .010 INCHES FOR A SINGLE SURFACE.

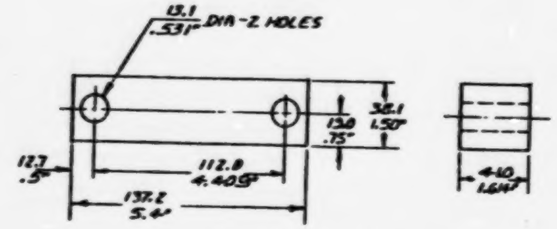
SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE CYLINDERS

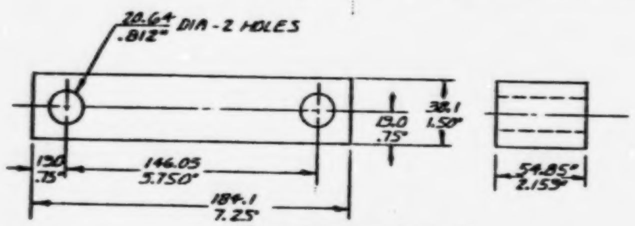
DRAWN MARIJ-ES Tellefson
CHECKED
SCALE HP.IF
DRAWING NO. 2006
REV
WEIGHT
OF


③
⑤
④
12.7 .50"
152.4 6.00"
12.7 .5"
G .25
13.1 .531" DIA-8 HOLES-B
11.11 .438" DIA-2 HOLES-A
1168.4 46.00"
838.2 33.00"
20.64 .812" DIA-16 HOLES-D
50.8 2.00" DIA-2 HOLES-E
140.0 5.512"
14.27 .562" DIA-12 HOLES-C
95 3.740"
190 7.480"
285.3 11.231
114.3 4.500"
1828.8 72.0"
165.1 6.50"
50.8 2.000"
177.8 7.000"
152.4 6.000"
76.2 3.000"
95.25 3.750"
190.5 7.500"
10.0 .394"
112.0 4.409"
56.0 2.205"
112.0 4.409
88.9 3.500"
457.2 18.000"
457.2 18.000"
88.9 3.500"
838.2 33.00"
101.6 4.00"
800.10 31.500"
800.10 31.500"
101.6 4.00"
914.4 36.0"
73.02 2.875"
73.02 2.875"
146.05 5.750"
1019.18 40.125"
1019.18 40.125"
146.05 5.750"
19 .75"
1219.2 48.00"
1219.2 48.00"
1295.4 51.0"
2590.8 102.0"
A
B
C
D
E

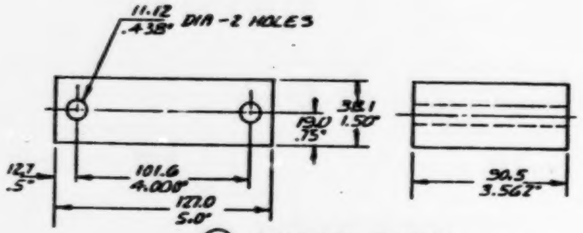
② PLATFORM WELDMENT


13.1 .531" DIA-2 HOLES
38.1 1.50"
13.0 .75"
12.7 .5"
112.0 4.409"
137.2 5.4"
41.0 1.614"

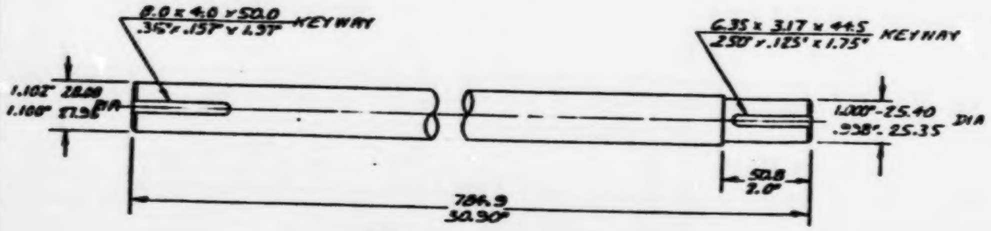
⑨ SPACER BLOCK
SCALE-HALF


20.64 .812" DIA-2 HOLES
19.0 .75"
38.1 1.50"
19.0 .75"
146.05 5.750"
184.1 7.25"
54.85 2.159"

⑩ SPACER BLOCK
SCALE-HALF


11.12 .438" DIA-2 HOLES
19.0 .75"
38.1 1.50"
12.7 .5"
101.6 4.000"
127.0 5.0"
90.5 3.562"

⑪ SPACER BLOCK
SCALE-HALF


8.0 x 4.0 x 50.0 .35" x .157" x 1.97" KEYWAY
6.35 x 3.17 x 44.5 .250" x .125" x 1.75" KEYWAY
1.102" 28.00
1.100" 27.95 DIA
1.000"-25.40
.998"-25.35 DIA
50.8 2.0"
784.9 30.90"

⑫ DRIVE SHAFT
SCALE-HALF

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	16			
	15			
	14			
	13			
	12		DRIVE SHAFT	AISI 1018 CFS-28 MM DIA
	11		SPACER BLOCK	ASTM-A36 HFS-1.50" THICK
	10		SPACER BLOCK	ASTM-A36 HFS-1.50" THICK
	9		SPACER BLOCK	ASTM-A36 HFS-1.50" THICK
	8			
	7			
	6			
2	5		FLANGE	AISI 1020 HFS-.50"x6.00"
2	4		FLANGE	AISI 1020 HFS-.50"x6.00"
1	3		PLATFORM	ASTM-A36 HFS-.75" THICK
~	2	2007-2	PLATFORM WELDMENT	
	1			
-2				

LIST OF MATERIAL

TOLERANCES ON

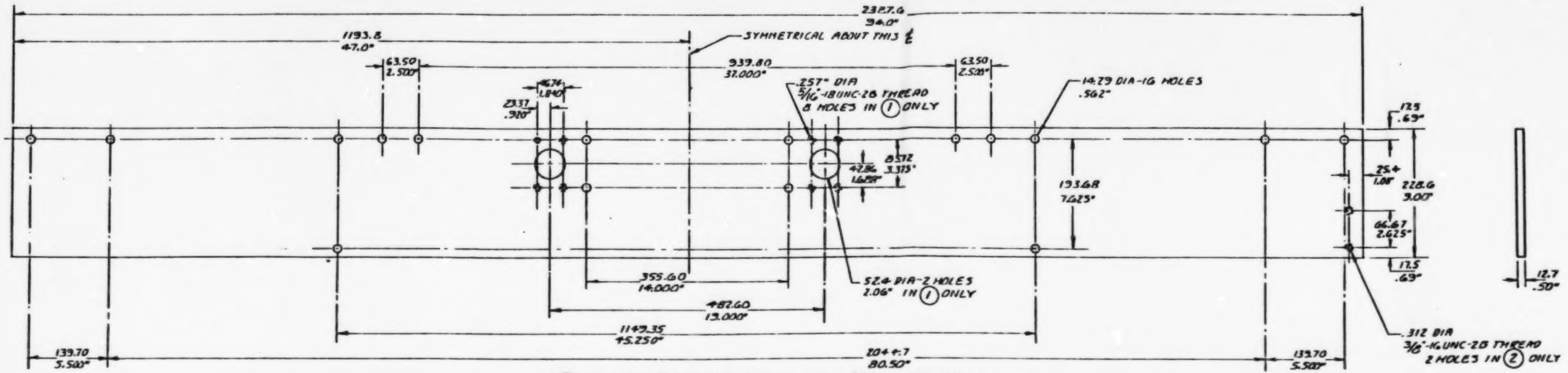
1 PLACE DEC.	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS PER MIL-STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

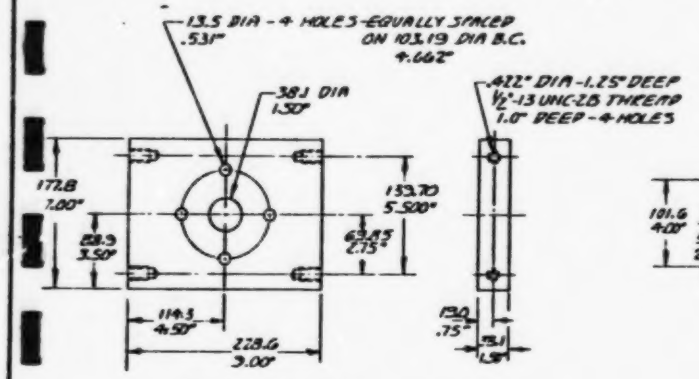
TITLE
HOIST DETAILS

DRAWN FEB 1605 Tellstar.
CHECKED
SCALE EIGHTH & NOTED
DRAWING NO. 2007
REV
WEIGHT
OF

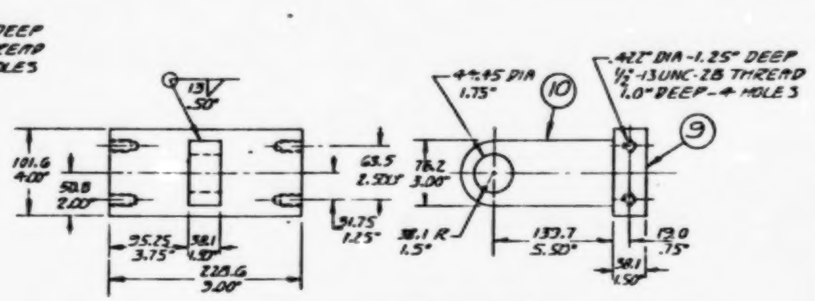

2327.6
94.0"
1193.8
47.0"
SYMMETRICAL ABOUT THIS ℄
63.50
2.500"
939.80
37.000"
63.50
2.500"
46.74
1.840"
23.37
.920"
.257" DIA
5/16"-18UNC-2B THREAD
8 HOLES IN ① ONLY
14.29 DIA-16 HOLES
.562"
42.86
1.688"
85.72
3.375"
193.68
7.625"
17.5
.69"
25.4
1.00"
228.6
9.00"
66.67
2.625"
17.5
.69"
12.7
.50"
355.60
14.000"
52.4 DIA-2 HOLES
2.06" IN ① ONLY
482.60
19.000"
1149.35
45.250"
139.70
5.500"
2044.7
80.50"
139.70
5.500"
.312 DIA
3/8"-16UNC-2B THREAD
2 HOLES IN ② ONLY

① CROSSHEAD PLATE-FRONT- OMIT 3/8" TAPPED HOLES

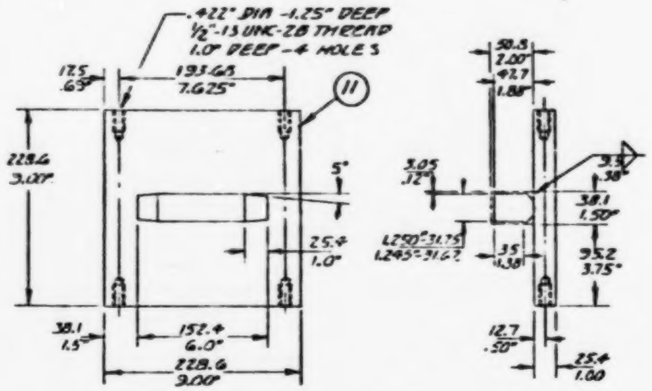
② CROSSHEAD PLATE-REAR -OMIT 5/16" TAPPED HOLES AND 2.06" DIA HOLES


13.5 DIA - 4 HOLES-EQUALLY SPACED
.531"
ON 103.19 DIA B.C.
4.062"
38.1 DIA
1.50"
.422" DIA-1.25" DEEP
1/2"-13 UNC-2B THREAD
1.0" DEEP-4 HOLES
177.8
7.00"
88.9
3.50"
139.70
5.500"
69.85
2.75"
114.3
4.50"
228.6
9.00"
19.0
.75"
38.1
1.50"

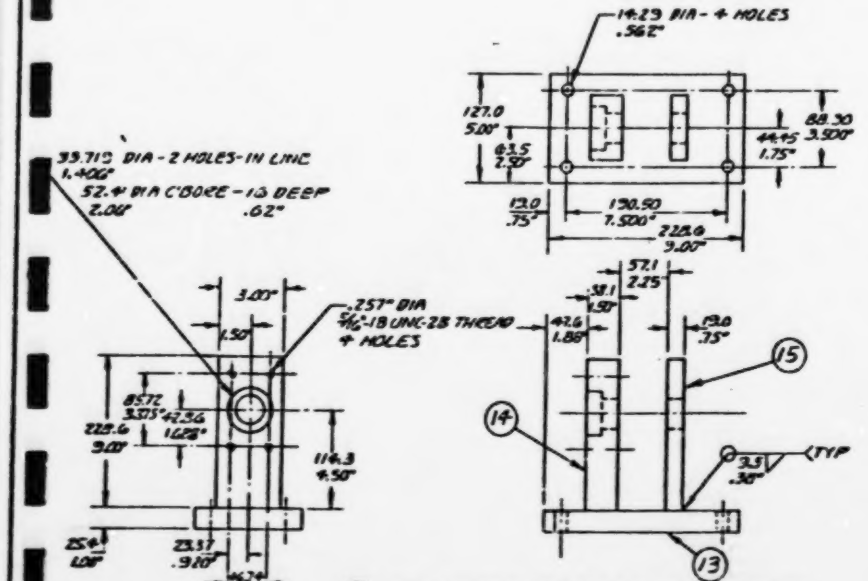
③ NUT PLATE


13
.50
101.6
4.00"
50.8
2.00"
63.5
2.50"
31.75
1.25"
95.25
3.75"
38.1
1.50"
228.6
9.00"
44.45 DIA
1.75"
⑩
.422" DIA-1.25" DEEP
1/2"-13UNC-2B THREAD
1.0" DEEP-4 HOLES
⑨
76.2
3.00"
38.1 R
1.5"
139.7
5.50"
19.0
.75"
38.1
1.50"

④ LOCK BRACKET WELDMENT


.422" DIA -1.25" DEEP
1/2"-13 UNC-2B THREAD
1.0" DEEP-4 HOLES
17.5
.69"
193.68
7.625"
⑪
228.6
9.00"
5°
25.4
1.0"
38.1
1.5"
152.4
6.0"
228.6
9.00"
50.8
2.00"
47.7
1.88"
3.05
.12"
9.5
.38"
38.1
1.50"
1.250"-31.75
1.245"-31.62
35
1.38
95.2
3.75"
12.7
.50"
25.4
1.00

⑤ GUIDE WELDMENT


14.29 DIA- 4 HOLES
.562"
127.0
5.00"
63.5
2.50"
88.90
3.500"
44.45
1.75"
19.0
.75"
190.50
7.500"
228.6
9.00"
35.719 DIA-2 HOLES-IN LINE
1.406"
52.4 DIA C'BORE-13 DEEP
2.06"
.62"
3.00"
1.50"
.257" DIA
5/16"-18UNC-2B THREAD
4 HOLES
85.72
3.375"
42.86
1.688"
228.6
9.00"
114.3
4.50"
25.4
1.00"
23.37
.920"
46.74
1.840"
57.1
2.25"
38.1
1.50"
47.6
1.88"
19.0
.75"
⑮
⑭
9.5
.38"
TYP
⑬

⑥ CYLINDER BRACKET WELDMENT

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00219
CANMET PROJECT NUMBER	:	420604

-6	-5	-4		ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
				20			
				19			
				18			
				17			
				16			
1				15		EAR	AISI 1020 HFS-.75" x 3.00"
1				14		EAR	AISI 1020 HFS-1.50" x 3.00"
1				13		BASE	AISI 1020 HFS-1.00" x 5.00"
	1			12		GUIDE	AISI 1018 CFS-1.50" x 2.00"
	1			11		BASE	ASTM-A36 HFS-1.00" THICK
		1		10		EAR	AISI 1020 HFS-1.50" x 3.00"
		1		9		BASE	AISI 1020 HFS-1.50" x 4.00"
				8			
				7			
~				6	2008-6	CYLINDER BRACKET WELD.	
	~			5	2008-5	GUIDE WELDMENT	
		~		4	2008-4	LOCK BRACKET WELD.	
				3	2008-3	NUT PLATE	ASTM-A36 HFS-1.50" THICK
				2	2008-2	CROSSHEAD PLATE-REAR	ASTM-A36 HFS-.50" THICK
				1	2008-1	CROSSHEAD PLATE-FRONT	ASTM-A36 HFS-.50" THICK

QTY
LIST OF MATERIAL

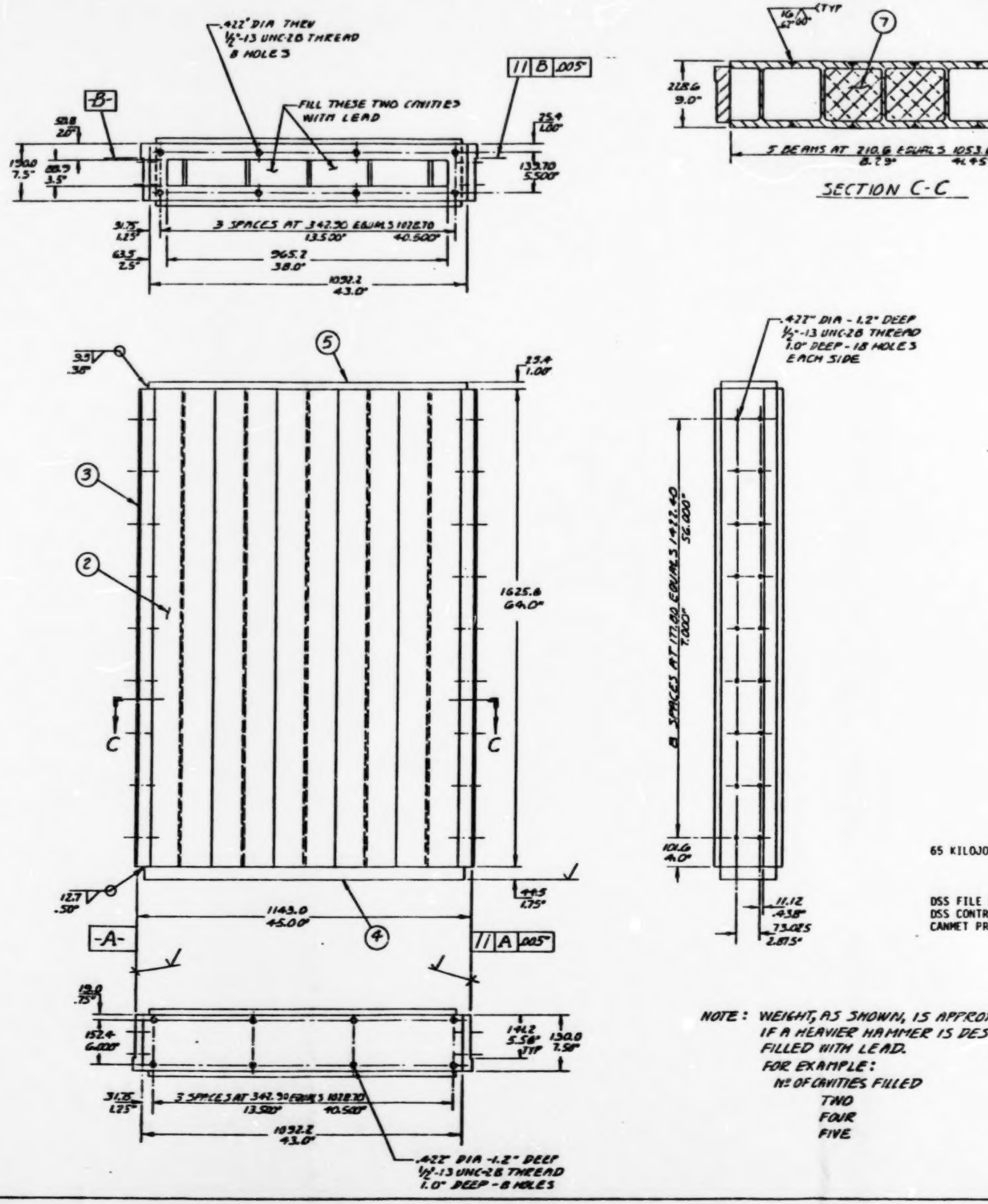
TOLERANCES ON			
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC	ANGLES
± .1	± .03	± .010	± 0° 30'

1. DIMENSIONS ARE IN INCHES
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH TO A MAX. OF .012 [illegible] A SINGLE SURFACE

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
CROSSHEAD DETAILS

DRAWN [illegible] Tellefsen
CHECKED
SCALE [illegible]
DRAWING NO 2008
REV
WEIGHT
OF


.422" DIA THRU
½"-13 UNC-2B THREAD
8 HOLES
FILL THESE TWO CAVITIES WITH LEAD
-B-
// B .005"
50.8
2.0"
190.0
7.5"
88.9
3.5"
25.4
1.00"
139.70
5.500"
31.75
1.25"
63.5
2.5"
3 SPACES AT 342.90 EQUALS 1028.70
13.500" 40.500"
965.2
38.0"
1092.2
43.0"
16
45°-60°
TYP
7
50.8
2.0"
228.6
9.0"
5 BEAMS AT 210.6 EQUALS 1053.0
8.29" 41.45"
12.7
.50"
TYP
SECTION C-C
3.5
.38"
5
25.4
1.00"
3
2
1625.6
64.0"
C
C
12.7
.50"
44.5
1.75"
1143.0
45.00"
-A-
4
// A .005"
.422" DIA - 1.2" DEEP
½"-13 UNC-2B THREAD
1.0" DEEP - 18 HOLES
EACH SIDE
8 SPACES AT 177.80 EQUALS 1422.40
7.000" 56.000"
101.6
4.0"
11.12
.438"
73.025
2.875"
19.0
.75"
152.4
6.000"
141.2
5.56"
TYP
190.0
7.50"
31.75
1.25"
3 SPACES AT 342.90 EQUALS 1028.70
13.500" 40.500"
1092.2
43.0"
.422" DIA - 1.2" DEEP
½"-13 UNC-2B THREAD
1.0" DEEP - 8 HOLES

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

NOTE: WEIGHT, AS SHOWN, IS APPROXIMATELY 5380LBS - 2440 KG
IF A HEAVIER HAMMER IS DESIRED, MORE CAVITIES CAN BE FILLED WITH LEAD.
FOR EXAMPLE:

Nº OF CAVITIES FILLED	TOTAL HAMMER WEIGHT
TWO	5380 LBS - 2440 KG
FOUR	8260 LBS - 3747 KG
FIVE	9700 LBS - 4400 KG

(USE ANTIMONY DOPED LEAD)

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	10			
	9			
	8			
2	7		LEAD	1440 LBS-(3512 CU.IN.)
	6			
1	5		TOP PLATE	ASTM-A36 HFS-1.00" THICK
1	4		BOTTOM PLATE	ASTM-A36 HFS-2.00" THICK
2	3		SIDE RAIL	ASTM-A36 HFS-2.00" THICK
5	2		BEAM-WIDEFLANGE	ASTM-A36 HFS-8.0" x 67 LBS
	1	2009	HAMMER WELDMENT	

LIST OF MATERIAL

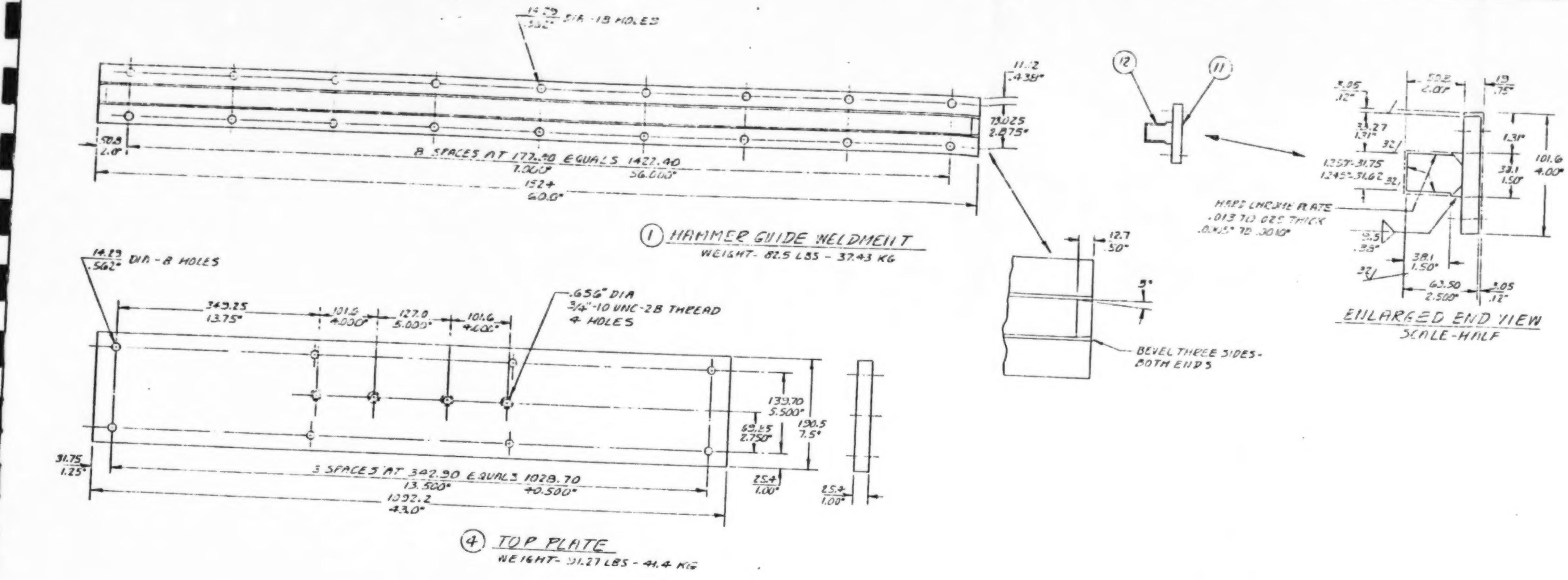
TOLERANCES ON			
1 PLACE DEC	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .016 MAX.
3. ALL SURFACE ROUGHNESS PER MIL-STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .016-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .003 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .003 PER INCH, TO A MAX. OF .010 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
HAMMER WELDMENT

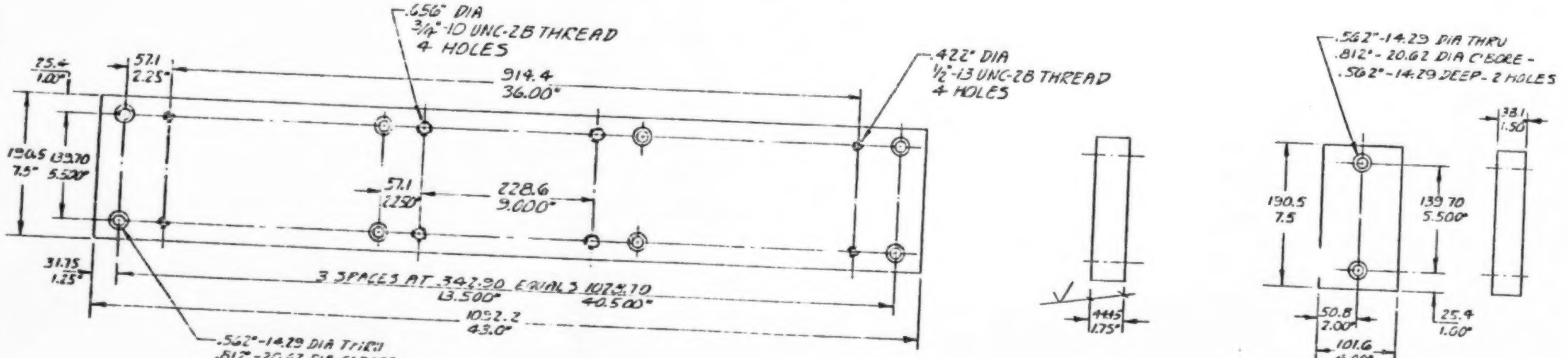
DRAWN FEB 27-83 Tellefson
CHECKED
SCALE EIGHTH
DRAWING NO. 2009
REV
WEIGHT SEE NOTE
OF


14.29 / .562" DIA - 19 HOLES
11.12 / .438"
73.025 / 2.875"
50.8 / 2.0"
8 SPACES AT 177.80 EQUALS 1422.40
7.000" / 56.000"
1524 / 60.0"
12
11
3.05 / .12"
50.8 / 2.00"
19 / .75"
33.27 / 1.31"
32
1.31"
101.6 / 4.00"
1.257-31.75
1.245-31.62
38.1 / 1.50"
HARD CHROME PLATE - .013 TO .025 THICK .0005" TO .0010"
9.5 / .38"
38.1 / 1.50"
63.50 / 2.500"
3.05 / .12"
12.7 / .50"
5°
BEVEL THREE SIDES - BOTH ENDS
14.29 / .562" DIA - 8 HOLES
.656" DIA 3/4"-10 UNC-2B THREAD 4 HOLES
349.25 / 13.75"
101.6 / 4.000"
127.0 / 5.000"
101.6 / 4.000"
139.70 / 5.500"
69.85 / 2.750"
190.5 / 7.5"
31.75 / 1.25"
3 SPACES AT 342.90 EQUALS 1028.70
13.500" / 40.500"
1092.2 / 43.0"
25.4 / 1.00"
25.4 / 1.00"

① HAMMER GUIDE WELDMENT
WEIGHT - 82.5 LBS - 37.43 KG

ENLARGED END VIEW
SCALE - HALF

④ TOP PLATE
WEIGHT - 91.27 LBS - 41.4 KG


.656" DIA 3/4"-10 UNC-2B THREAD 4 HOLES
25.4 / 1.00"
57.1 / 2.25"
914.4 / 36.00"
.422" DIA 1/2"-13 UNC-2B THREAD 4 HOLES
190.5 / 7.5"
139.70 / 5.500"
57.1 / 2.250"
228.6 / 9.000"
31.75 / 1.25"
3 SPACES AT 342.90 EQUALS 1028.70
13.500" / 40.500"
1092.2 / 43.0"
44.45 / 1.75"
.562"-14.29 DIA THRU .812"-20.62 DIA C'BORE - .562"-14.29 DEEP - 8 HOLES
.562"-14.29 DIA THRU .812"-20.62 DIA C'BORE - .562"-14.29 DEEP - 2 HOLES
38.1 / 1.50
190.5 / 7.5
139.70 / 5.500"
50.8 / 2.00"
101.6 / 4.00"
25.4 / 1.00"

⑤ BOTTOM PLATE
WEIGHT - 159.7 LBS - 72.45 KG

⑥ STRIKER
HEATTREAT TO 150,000 PSI ULT
125,000 PSI MIN YIELD

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	16			
	15			
	14			
	13			
1	12		GUIDE BAR	AISI 1020 HFS - 1.50" x 2.00"
1	11		BASE PLATE	AISI 1020 HFS - .75" x 4.00"
	10			
	9			
	8			
	7			
	6		STRIKER	AISI 4150 HFS - 1.50" x 4.00"
	5		BOTTOM PLATE	ASTM-A36 HFS - 2.00" THICK
	4		TOP PLATE	ASTM-A36 HFS - 1.00" THICK
	3			
	2			
~	1	2010-1	HAMMER GUIDE WELDMT	

LIST OF MATERIAL

TOLERANCES ON

1 PLACE DEC	2 PLACE DEC	3 PLACE DEC	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON, SASKATCHEWAN

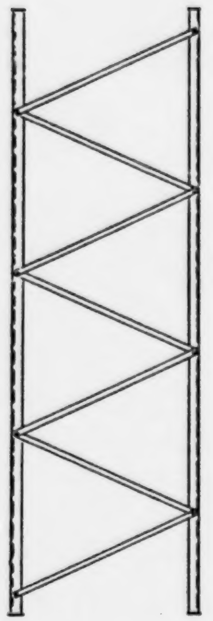
TITLE
HAMMER DETAILS

DRAWN MAR 13-83 Tellefsen.
CHECKED
DRAWING NO. 2010
REV A
SCALE QUARTER & NOTED
WEIGHT
OF

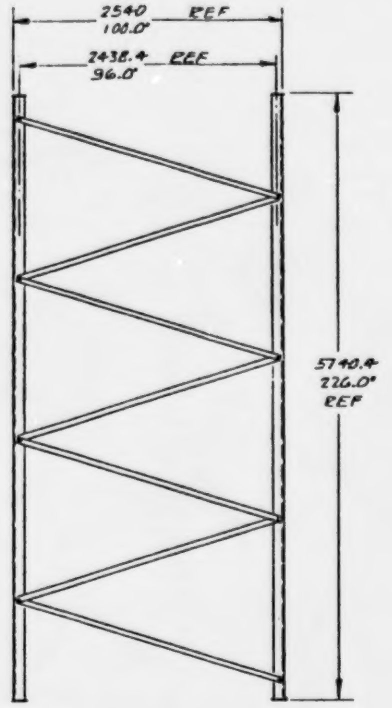
65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

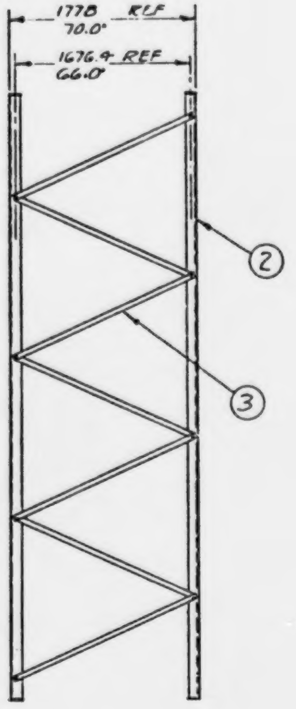
DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00219
CANMET PROJECT NUMBER	:	420604



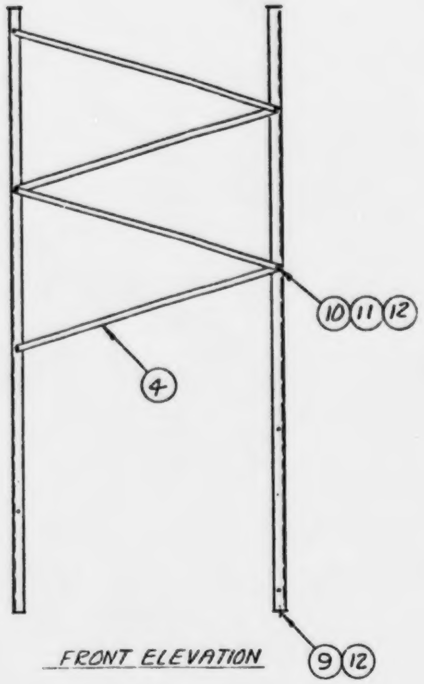
RIGHT SIDE ELEVATION


2540 REF
100.0"
2438.4 REF
96.0"
5740.4
226.0"
REF

REAR ELEVATION

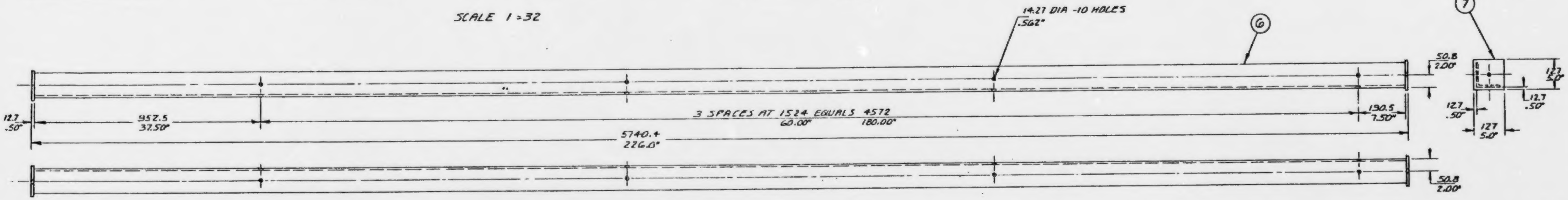

1778 REF
70.0"
1676.4 REF
66.0"
②
③

LEFT SIDE ELEVATION

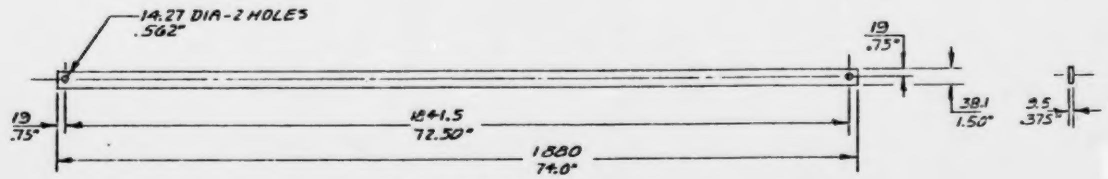


FRONT ELEVATION

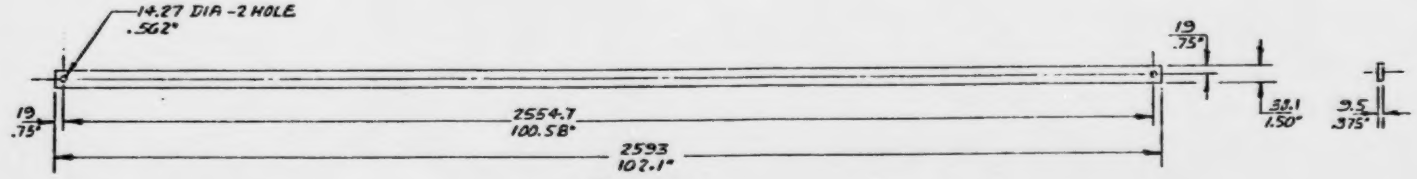
SCALE 1 = 32


14.27 DIA -10 HOLES
.562"
⑥
⑦
50.8
2.00"
127
5.0"
12.7
.50"
12.7
.50"
127
5.0"
12.7
.50"
952.5
37.50"
3 SPACES AT 1524 EQUALS 4572
60.00" 180.00"
190.5
7.50"
5740.4
226.0"
50.8
2.00"

② LEG WELDMENT


14.27 DIA-2 HOLES
.562"
19
.75"
38.1
1.50"
9.5
.375"
19
.75"
1841.5
72.50"
1880
74.0"

③ BRACE


14.27 DIA -2 HOLE
.562"
19
.75"
38.1
1.50"
9.5
.375"
19
.75"
2554.7
100.58"
2593
102.1"

④ BRACE

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

-2	-1	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
		14			
		13			
	33	12		LOCKWASHER	1/2"
	29	11		HEX NUT	1/2"-13 UNC-2B
	29	10		HEX CAP SCREW	1/2"-13 UNC-2A × 1.75" LG
	4	9		HEX CAP SCREW	1/2"-13 UNC-2A × 1.25" LG
		8			
2		7		END PLATE	AISI 1020 HFS-.50" × 5.00"
1		6		ANGLE	ASTM-A36 HFS-4.0" × 4.0" × .25"
		5			
	11	4		BRACE	AISI 1020 HFS-.375" × 1.50"
	14	3		BRACE	AISI 1020 HFS-.375" × 1.50"
~	4	2		LEG WELDMENT	
		1		STIFFENER FRAME	

QTY

LIST OF MATERIAL

TOLERANCES ON

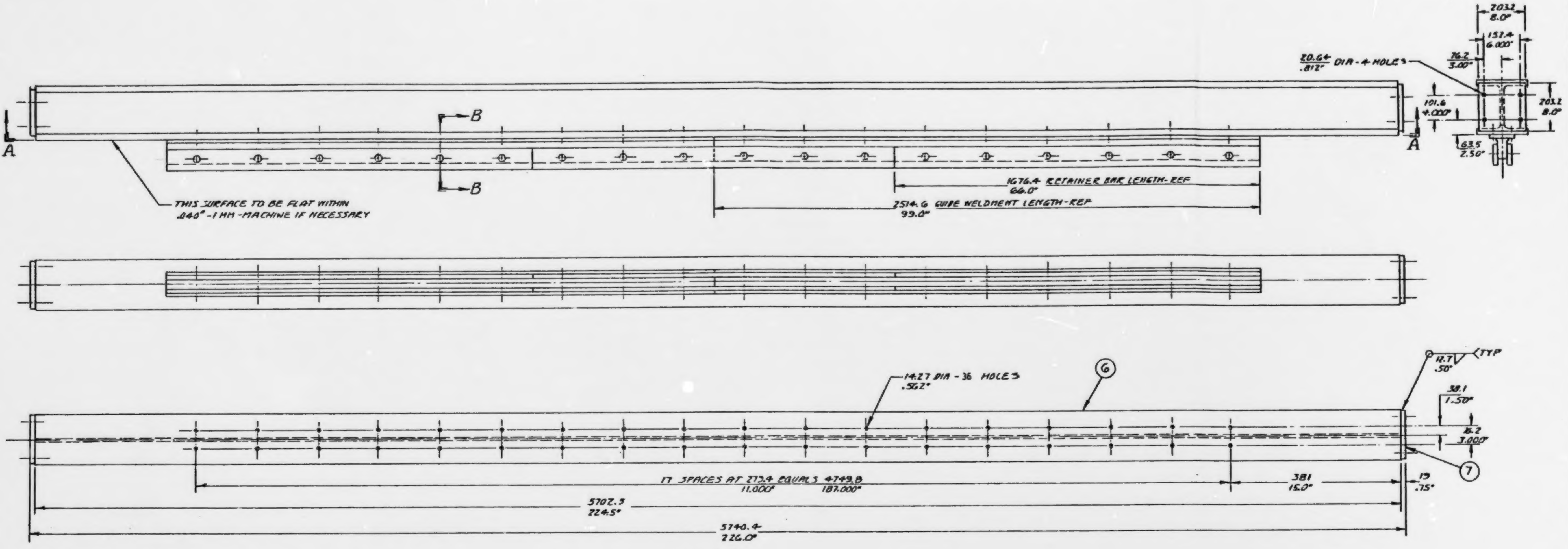
1 PLACE DEC	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

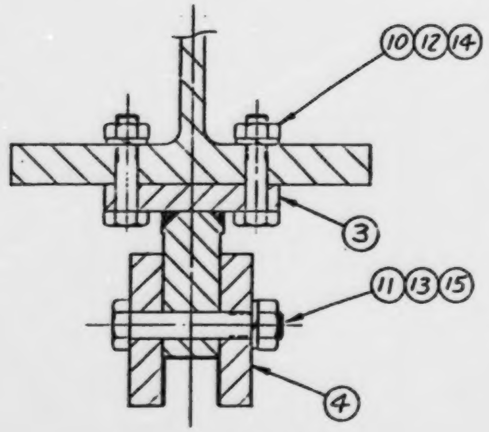
TITLE
STIFFENER FRAME

DRAWN MAR 20-83 Tsllefr..
CHECKED
SCALE QUARTER & NOTED
DRAWING NO. 2011
REV
WEIGHT
OF


A
A
B
B
THIS SURFACE TO BE FLAT WITHIN .040" - 1 MM - MACHINE IF NECESSARY
1676.4 RETAINER BAR LENGTH - REF 66.0"
2514.6 GUIDE WELDMENT LENGTH - REF 99.0"
20.64 / .812" DIA - 4 HOLES
203.2 8.0"
152.4 6.000"
76.2 3.00"
101.6 4.000"
203.2 8.0"
63.5 2.50"
14.27 DIA - 36 HOLES .562"
6
12.7 .50"
TYP
38.1 1.50"
76.2 3.000"
7
17 SPACES AT 279.4 EQUALS 4749.8
11.000" 187.000"
381 15.0"
19 .75"
5702.3 224.5"
5740.4 226.0"

VIEW A-A

② COLUMN WELDMENT



SECTION B-B

SCALE - HALF

	-2	-1	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
			16			
		18	15		LOCKWASHER	5/8"
		36	14		LOCKWASHER	1/2"
		18	13		HEX NUT	5/8"-11 UNC-2B
		36	12		HEX NUT	1/2"-13 UNC-2B
		18	11		HEX CAP SCREW	5/8"-11 UNC-2A x 3.5" LONG
		36	10		HEX CAP SCREW	1/2"-13 UNC-2A x 2.25" LONG
			9			
			8			
	2		7		END PLATE	ASTM-A36 HFS - .75 THICK
	1		6		COLUMN	ASTM-A36 HFS - W8 x 67 LB
			5			
		6	4	2013-2	RETAINER BAR	
		2	3	2013-1	GUIDE WELDMENT	
	~	1	2		COLUMN WELDMENT	
		~	1		COLUMN ASSEMBLY	

QTY

LIST OF MATERIAL

TOLERANCES ON			
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC.	ANGLES
± .1	± .[illegible]	± .010	± 0° 30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS [illegible] PER MIL STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.020.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .[illegible] T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .[illegible] T.I.R.
7. NORMALITY SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
COLUMN ASSEMBLY

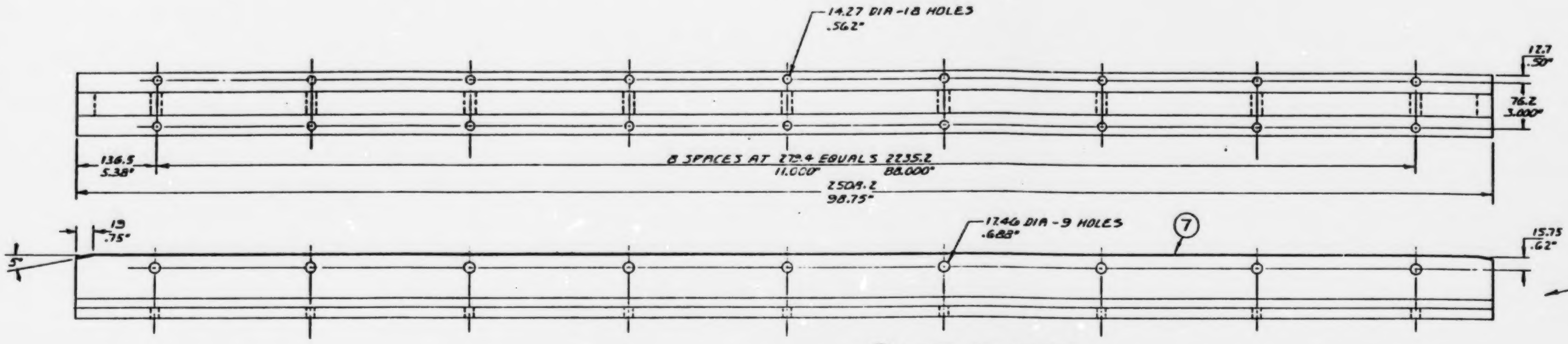
DRAWN [illegible]-83 Tellefson
CHECKED
SCALE [illegible]

DRAWING NO 2012
REV
WEIGHT
OF

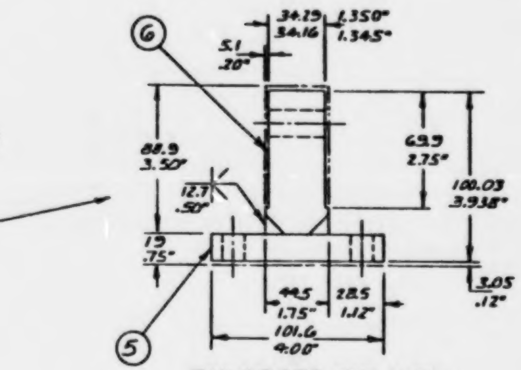
65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

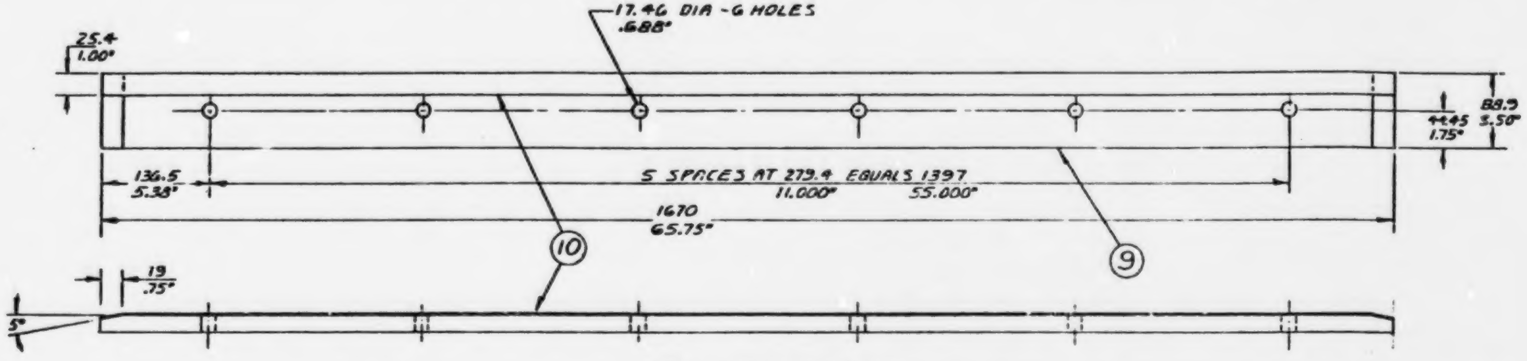

14.27 DIA - 18 HOLES
.562"
12.7
.50"
76.2
3.000"
136.5
5.38"
8 SPACES AT 279.4 EQUALS 2235.2
11.000" 88.000"
2509.2
98.75"
19
.75"
5°
17.46 DIA - 9 HOLES
.688"
⑦
15.75
.62"

① GUIDE WELDMENT


⑥
5.1
.20"
34.29
34.16
1.350"
1.345"
88.9
3.50"
69.9
2.75"
100.03
3.938"
12.7
.50"
19
.75"
44.5
1.75"
28.5
1.12"
3.05
.12"
101.6
4.00"
⑤

ENLARGED END VIEW

SCALE - HALF


25.4
1.00"
17.46 DIA - 6 HOLES
.688"
88.9
3.50"
44.45
1.75"
136.5
5.38"
5 SPACES AT 279.4 EQUALS 1397
11.000" 55.000"
1670
65.75"
⑩
⑨
19
.75"
5°

② RETAINER BAR

				14			
				13			
				12			
				11			
		66"		10		BEARING TAPE - GARLOCK	MULTIFIL # 426 - .030" × 1.00" WIDE
		1		9		BAR	AISI 1018 CFF - .75" × 3.50"
				8			
			99"	7		BEARING TAPE - GARLOCK	MULTIFIL # 426 - .030" × 1.00" WIDE
			1	6		GUIDE	AISI 1020 HFS - 1.75" × 3.50"
			1	5		BASE	AISI 1020 HFS - .75" × 4.00"
				4			
				3			
		~		2	2013-2	RETAINER BAR	
			~	1	2013-1	GUIDE WELDMENT	
		-2	-1	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
			QTY	LIST OF MATERIAL			

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00213
CANMET PROJECT NUMBER	:	420604

TOLERANCES ON

1 PLACE DEC.	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.020.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .020 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .010 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
COLUMN DETAILS

DRAWN MAR 21-83 Tillefsen	DRAWING NO. 2013	REV
CHECKED		
SCALE QUARTER & NOTED	WEIGHT	OF

GARLOCK 201 ADHESIVE

Garlock
Garlock
ADHESIVE
A
B

for bonding MULTIFIL 426 BEARING TAPE

Garlock No. 201 adhesive is a two-component epoxy which, after curing, provides an extremely tough bond. Designed for use with MULTIFIL 426 bearing tape, the adhesive effectively joins a wide variety of other materials, as well.

The cured bond is resistant to temperatures from −60° to 150°F (short time 200°F), cold and hot water, humidity, weathering, sunlight, weak acids, alkalies and most solvents.

Mixing. Mix equal parts by weight or volume of components A and B. Better mixing is obtained if part B is preheated to 125-135°F prior to blending. Stir thoroughly until creamy in appearance, after which the adhesive is ready for use. Stirring can be done manually or with a power drill and plain drill rod, moving the rod throughout the adhesive to achieve a thorough blend (Fig. 7). Mix only the quantity needed for the job at hand since the pot life of the adhesive is about one hour after mixing.

Curing. After preparation of the machine surface and tape, and application of the adhesive as described on page 3, the adhesive will cure at room temperature to a strong joint in approximately 14 hours. Raising the temperature of the metal components to a maximum of 150°F and holding that temperature accelerates cure time to just three hours.

Coverage. Garlock 201 adhesive components are available in pints, quarts and gallons. One pint each of component A and B covers approximately 25 sq. ft. One quart of each covers 50 sq. ft. and one gallon each of A and B covers 200 sq. ft.

Storage. Although Garlock 201 adhesive parts A and B will burn, they contain no volatile flammable solvents. Shipping containers should be kept tightly closed and stored in a cool, dry place. In the unmixed state, the shelf life is indefinite.

Notice: Since the use to which this adhesive may be put and the manner of storing and handling are beyond our control, no guarantee, expressed or implied, is made as to the effects of such use—whether or not in accordance with these directions. Specifications are subject to change without notice.

PHYSICAL PROPERTIES
of MULTIFIL 426
BEARING TAPE

	ASTM Test Method	MULTIFIL 426
Specific Gravity	D-1457-62	2.34-2.40
Hardness (Shore D-78°F.)		84
Ultimate Tensile Strength (psi)	D-1457-62	2400
Ultimate Elongation (%)	D-1457-62	137
Compressive Strength (psi) at 0.2% Yield Stress	D-695-63	1400
Deformation under Load (%) 78°F., 2000 psi, 24 hrs.	D-621-59 (Modified)	1.2 (bonded)
Coefficient of Linear Thermal Expansion in./in./°F. x 10^{5}	D-696-90	4.9
Thermal Conductivity (BTU/hr./sq. ft./°F./in.)	Cenco Fitch	4.4

For additional information or the name of your local distributor, please contact Garlock Bearings Inc, 700 Mid Atlantic Parkway, Thorofare, N.J. 08086, (609) 848-3200, Telex: 84-5151.

Garlock Bearings Inc

Colt Industries

Printed in U.S.A.   G89749 20M83 180 AP

Garlock Bearings Inc

Colt Industries

how to improve your ways with MULTIFIL 426 bearing tape

here is the efficient, economical bearing tape for machine tool ways, gibs and other sliding applications

MULTIFIL® 426 BEARING TAPE

for machine tool ways, gibs and other sliding applications

MULTIFIL 426 tape is a superior sliding bearing material developed specifically for machine tool ways, gibs and other sliding applications. This unique material is a blend of virgin PTFE (polytetrafluoroethylene) and a combination of fillers which vastly improve the bearing properties of the base resin.

This bearing tape is widely used by machine tool rebuilders and in-plant personnel to restore existing equipment to like new precision, as well as by many leading machine tool manufacturers. The tape is easy to apply to any clean rigid substrate, inexpensive and provides remarkable performance.

As a sliding bearing material, MULTIFIL 426 tape is unequalled for providing high compressive strength and load carrying capabilities, low friction, precise positioning accuracy and minimal wear—with or without lubrication.

In addition to its rapid, easy installation and economy, the use of MULTIFIL 426 tape eliminates stick-slip, chattering, scuffing, galling due to lube breakdown, scoring, uneven wear and override. It reduces or eliminates the need for lubrication, assures improved positioning accuracy and provides almost indefinite service life in most machine tool applications.

Typical applications include milling machines, planers, grinders, vertical boring machines and many more. This tape is particularly recommended for numerically-controlled machines where positioning accuracy and reproducibility are especially critical.

MULTIFIL 426 bearing tape is the ideal replacement for ways of hardened steel, bronze and other metals . . . hydrostatic support systems . . . ball or roller bearings . . . and other types of bearing tapes.

DESIGN FEATURES

Low Friction. MULTIFIL 426 tape provides smooth way motion without stick-slip due to its similar values for static and dynamic friction.

Tests on machine tools at pressures below 50 psi have shown that filled PTFE can provide a coefficient of friction as low as 0.07 when operated dry. These tests also show that with lubrication, even lower frictional values down to 0.05 can be achieved without causing table override or any loss of positioning accuracy. Increased surface pressures will further improve these values.

Wear. Without lubrication, MULTIFIL 426 bearing tape has the remarkably low wear rate of less than 0.005 in./1000 hrs. at PV values up to 10,000 psi-fpm. The low PV's experienced in machine tool service cause very little wear. In lubricated service, actual field tests have proved that wear of MULTIFIL tape is negligible over extended periods of operation.

Compressive Strength. The excellent compressive strength of this material—only 1% deformation at 1000 psi—provides high load carrying capabilities. MULTIFIL 426 tape can operate at PV's in excess of 10,000 psi-fpm—particularly with lubrication. For optimum performance, PV levels below 5000 psi-fpm and adequate lubrication are normally recommended. The material's other outstanding physical properties are given in the table on page 4.

AVAILABLE SIZES

To meet the great majority of machine tool applications, MULTIFIL 426 bearing tape is available in standard thicknesses of 0.015", 0.030", 0.060", 0.090" and 0.125", in standard widths of 12" and 24", and lengths up to 100 ft. Other thicknesses are available on special order. Tapes are normally furnished in roll form cut to the specified length.

RAPID, EASY INSTALLATION

MULTIFIL 426 tape can be applied to any properly prepared machine surface using a good quality industrial epoxy adhesive. Adhesive bonding eliminates the need for holes and fastening devices, improves the fatigue life of the surface material and permits the use of lighter gage materials for maximum economy.

Surface Preparation. The surface to which the tape will be applied must be clean. To remove oxidation and other contamination, various cleaning methods can be used, including sanding, grinding, sandblasting or acid etching. A final surface finish of 125 rms or better is recommended for proper bonding. The surface should then be thoroughly degreased with a solvent such as trichloroethane and wiped clean with a dry, lint-free cloth. An air gun can be used to accelerate drying the clean surface (Fig. 1).

Preparing the Tape. The tape can be easily cut to the desired length and width with a utility knife (Fig. 2). The tape is chemically etched on one side to assure optimum bonding. To positively identify the bondable side, simply apply water to both sides. The water will bead up on the bearing side, while the bonding side will appear wet (Fig. 3). Care should be taken to keep the bonding side of the tape clean since any foreign material, including moisture, finger marks, grease or oil will prevent a perfect bond.

Preparing the Adhesive. A good two-part room temperature cure epoxy adhesive, such as Garlock 201 adhesive (see page 4) should be used to provide high shear strength. The two components can be easily blended by using a powered hand drill with a plain drill rod, moving the rod throughout the adhesive to achieve a homogeneous blend (Fig. 7 on page 4).

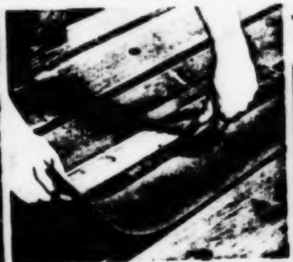
Applying the Adhesive and Tape. A thin, even coat of adhesive should be applied to both the tape and machine surface. The total glue line should be approximately 5-6 mils after assembly. Edge locators (Fig. 4) should be used to prevent the tape from sliding out of position. C-clamps or other devices which cause uneven pressure should not be used.

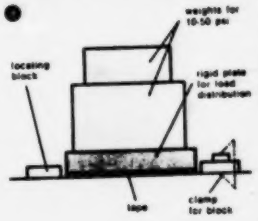
After careful positioning, the tape should be covered with a rigid flat pressure plate, with additional weights evenly distributed to provide loading of at least 10 psi but not more than 50 psi (Fig. 5). The use of grease-proof release paper to prevent cleanup problems is also recommended.

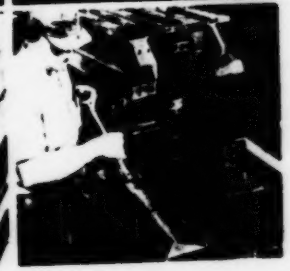
Final Sizing. After the adhesive is cured (usually overnight), the bearing tape can be easily machined, ground or hand scraped (Fig. 6) to the dimensional tolerances required by the specific application. For grinding large areas, a coolant—preferably a water soluble, oil emulsion grinding fluid, diluted 100:1—should be used.

Lubrication grooves can also be machined into the tape. The depth of these grooves should be less than the thickness of the tape to prevent peeling and avoid problems in the event of repair or replacement. The final machining operation compensates for variations in the tolerance on the machine surface and the thickness of the tape and bond line.

Mating Surfaces. For optimum performance, the surface finish of the mating material should not exceed 20 AA. Steel is generally used. If cast iron is used, a finer finish (10 AA) is recommended due to the open surface texture of this material.

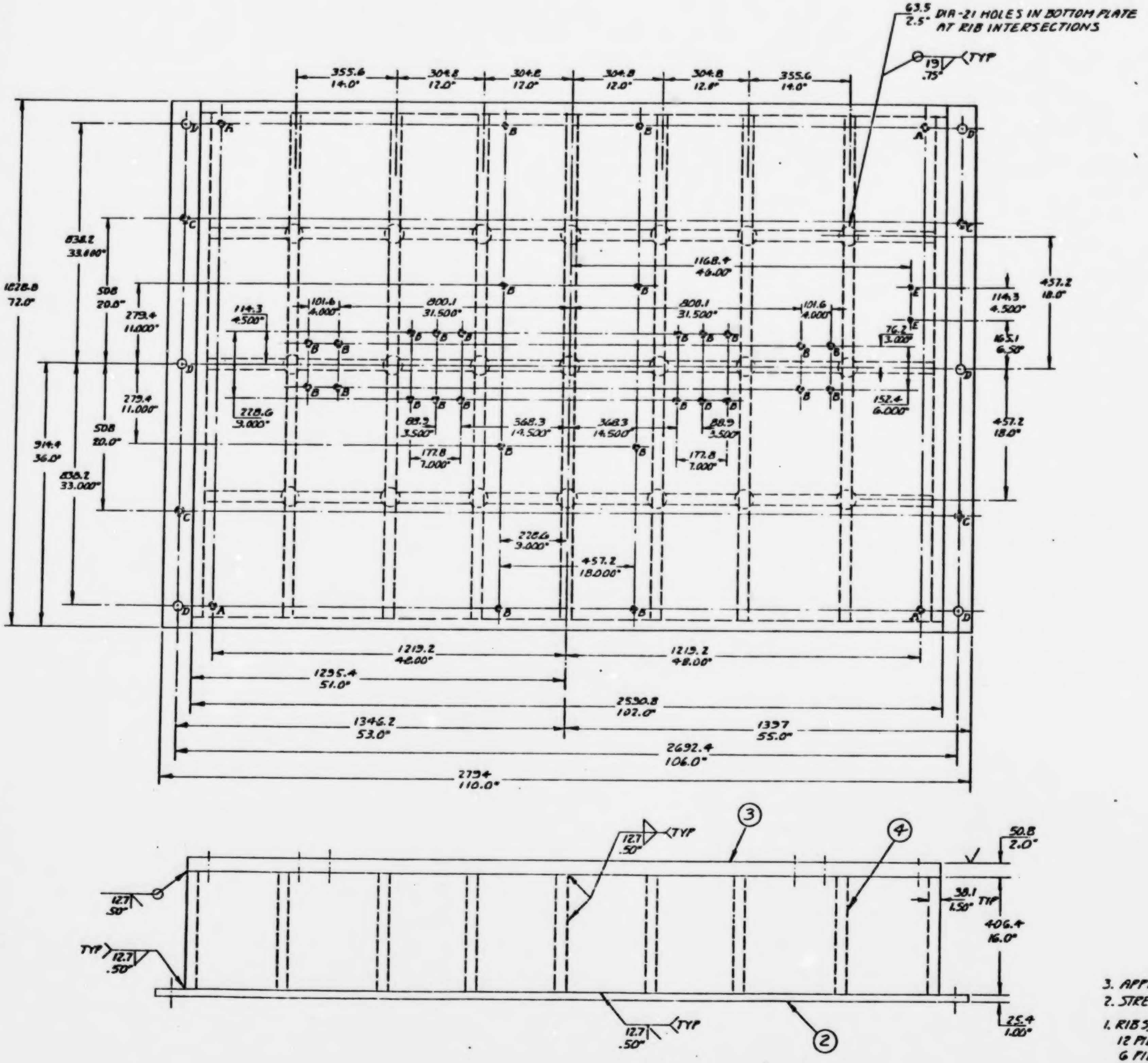






Garlock Bearings Inc

© Copyright 1974 Garlock Inc


63.5 / 2.5" DIA-21 HOLES IN BOTTOM PLATE AT RIB INTERSECTIONS
19 / .75" TYP
355.6 / 14.0"
304.8 / 12.0"
304.8 / 12.0"
304.8 / 12.0"
304.8 / 12.0"
355.6 / 14.0"
1828.8 / 72.0"
838.2 / 33.000"
508 / 20.0"
279.4 / 11.000"
114.3 / 4.500"
101.6 / 4.000"
800.1 / 31.500"
1168.4 / 46.00"
800.1 / 31.500"
101.6 / 4.000"
76.2 / 3.000"
457.2 / 18.0"
114.3 / 4.500"
165.1 / 6.50"
152.4 / 6.000"
457.2 / 18.0"
279.4 / 11.000"
228.6 / 9.000"
508 / 20.0"
914.4 / 36.0"
838.2 / 33.000"
88.9 / 3.500"
368.3 / 14.500"
368.3 / 14.500"
88.9 / 3.500"
177.8 / 7.000"
177.8 / 7.000"
228.6 / 9.000"
457.2 / 18.000"
A
B
C
D
E
1219.2 / 48.00"
1219.2 / 48.00"
1295.4 / 51.0"
2590.8 / 102.0"
1346.2 / 53.0"
1397 / 55.0"
2692.4 / 106.0"
2794 / 110.0"
③
④
②
12.7 / .50" TYP
50.8 / 2.0"
38.1 / 1.50" TYP
406.4 / 16.0"
25.4 / 1.00"

HOLE SCHEDULE

CODE LETTER	QUANTITY	DESCRIPTION
A	4	1/2"-13 UNC-2B THREAD
B	28	3/4"-10 UNC-2B THREAD
C	4	1"-8 UNC-2B THREAD
D	6	1.312" DIA
E	2	3/8"-16 UNC-2B THREAD

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

3. APPROX WEIGHT - 6,260 KG - 13,800 LBS
2. STRESS RELIEVE AFTER WELDING
1. RIBS, ITEM 4, CONSIST OF:
12 PIECES - 1.5" × 16.0" × 10.5" LONG
6 PIECES - 1.5" × 16.0" × 10.75" LONG
6 PIECES - 1.5" × 16.0" × 12.5" LONG
9 PIECES - 1.5" × 16.0" × 69.0" LONG
2 PIECES - 1.5" × 16.0" × 102.0" LONG
NOTES:

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	6			
	5			
	4	SEE NOTE 1.	RIBS	ASTM-A36 HFS-1.50" THICK
1	3		TOP PLATE	ASTM-A36 HFS-2.50" THICK
1	2		BOTTOM PLATE	ASTM-A36 HFS-1.00" THICK
	1		BASE WELDMENT	

LIST OF MATERIAL

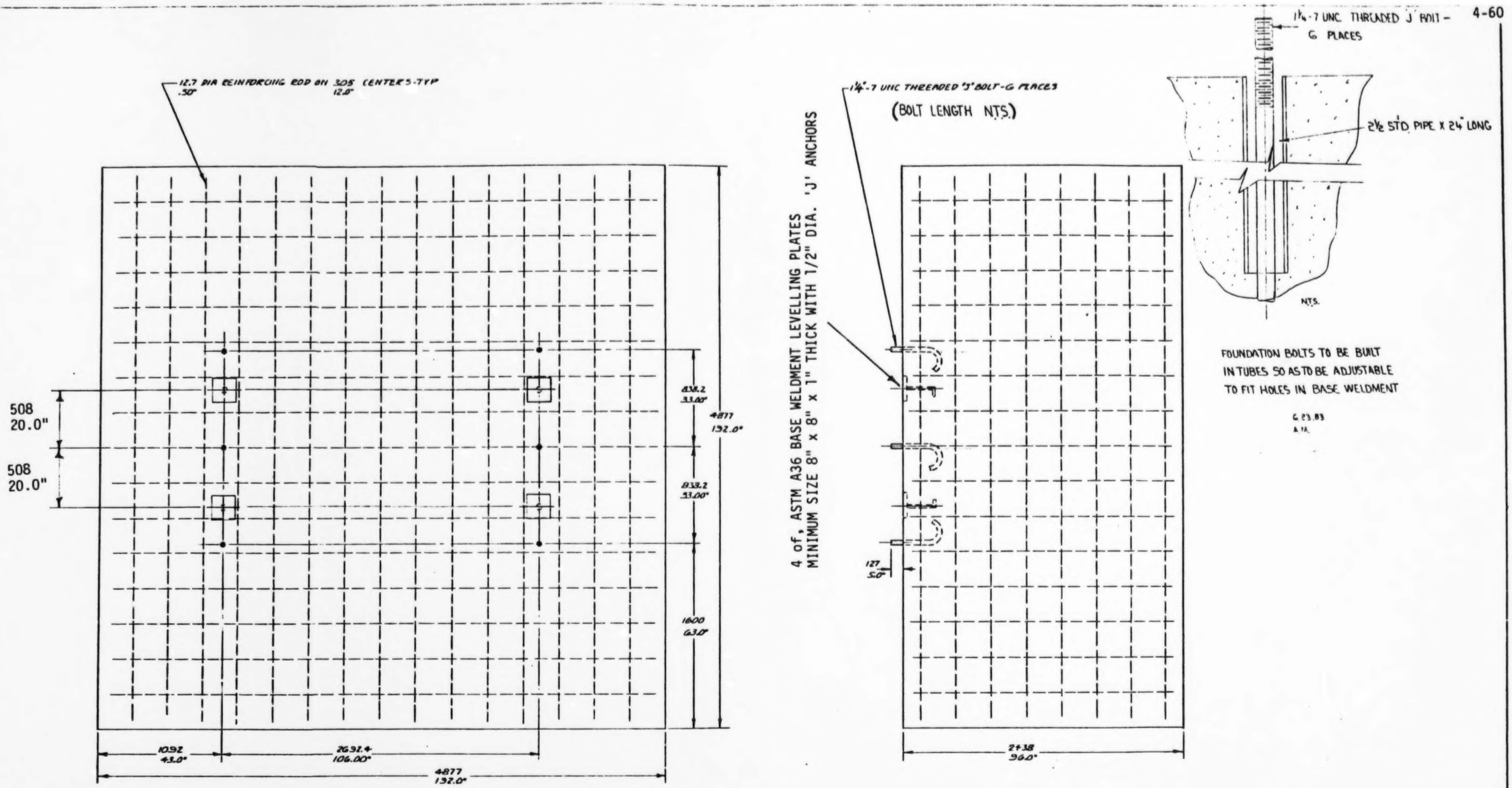
TOLERANCES ON			
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC.	ANGLES
±.1	±.03	±.010	±0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
BASE WELDMENT

DRAWN MAR 22-83 Tslbfso.
CHECKED
SCALE EIGHTH
DRAWING NO. 2014
REV
WEIGHT
OF


12.7 DIA REINFORCING ROD ON 305 CENTERS-TYP
.50" 12.0"
508
20.0"
508
20.0"
838.2
33.00"
833.2
33.00"
1600
63.0"
4877
132.0"
1092
43.0"
2632.4
106.00"
4877
132.0"
1¼"-7 UNC THREADED 'J' BOLT-6 PLACES
(BOLT LENGTH NTS)
4 of, ASTM A36 BASE WELDMENT LEVELLING PLATES
MINIMUM SIZE 8" x 8" x 1" THICK WITH 1/2" DIA. 'J' ANCHORS
127
5.0"
2438
96.0"
1¼-7 UNC THREADED J BOLT -
6 PLACES
2½ STD PIPE X 24" LONG
N.T.S.

FOUNDATION BOLTS TO BE BUILT
IN TUBES SO AS TO BE ADJUSTABLE
TO FIT HOLES IN BASE WELDMENT

6.23.83
A.M.

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00219
CANMET PROJECT NUMBER	:	420604

1. APPROX WEIGHT 136,018 KG -300000 LBS

NOTES:

	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
QTY	LIST OF MATERIAL			

TOLERANCES ON

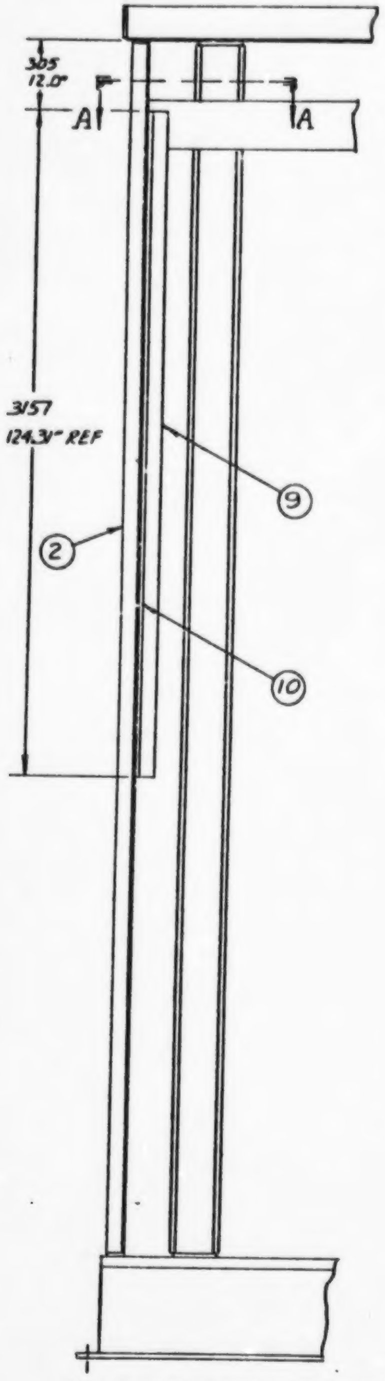
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX OF .012 INCHES FOR A SINGLE SURFACE.

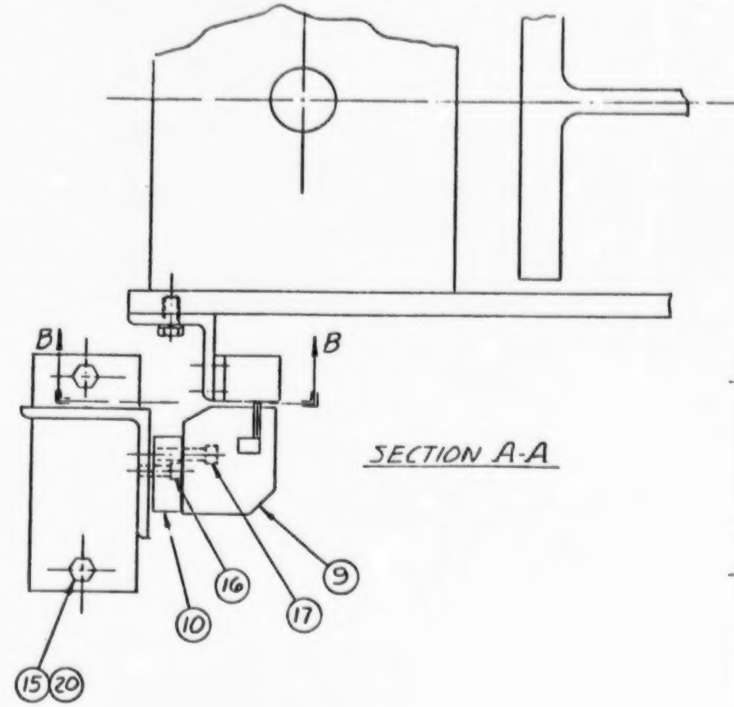
SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
FOUNDATION

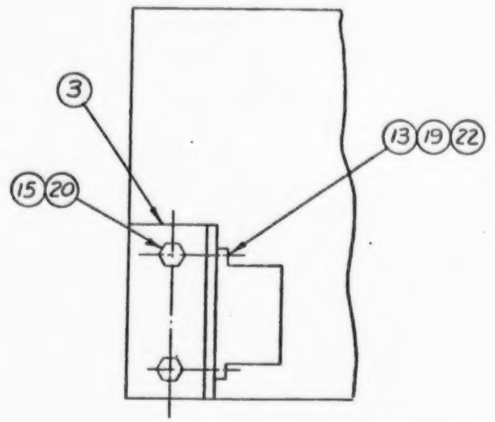
DRAWN MAR 26-83 Tsllifsa.
CHECKED
SCALE SIXTEENTH
DRAWING NO. 2015
REV
WEIGHT
OF


305
12.0"
A
A
3157
124.31" REF
9
2
10

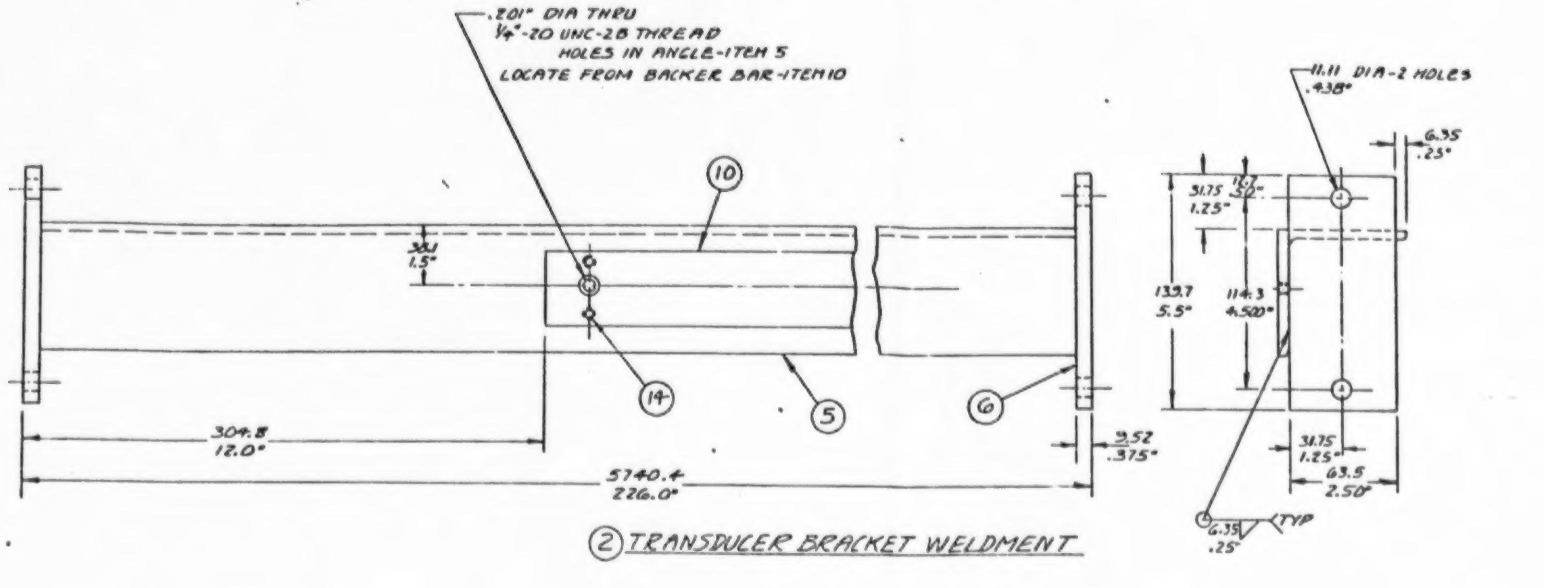
REAR ELEVATION OF TOWER
SCALE - SIXTEENTH


B
B
15
20
10
16
17
9

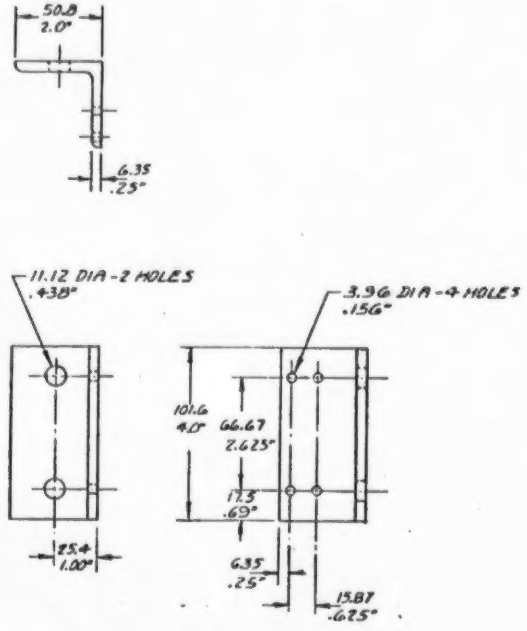
SECTION A-A


3
15
20
13
19
22

SECTION B-B


.201" DIA THRU
1/4"-20 UNC-2B THREAD
HOLES IN ANGLE-ITEM 5
LOCATE FROM BACKER BAR-ITEM 10
10
38.1
1.5"
14
5
6
304.8
12.0"
5740.4
226.0"
9.52
.375"
11.11 DIA-2 HOLES
.438"
6.35
.25"
31.75
1.25"
12.7
.50"
139.7
5.5"
114.3
4.500"
31.75
1.25"
63.5
2.50"
6.35
.25"
TYP

② TRANSDUCER BRACKET WELDMENT


50.8
2.0"
6.35
.25"
11.12 DIA-2 HOLES
.438"
3.96 DIA-4 HOLES
.156"
101.6
4.0"
66.67
2.625"
17.5
.69"
25.4
1.00"
6.35
.25"
15.87
.625"

③ READER HEAD BRACKET

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

-2	-1	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	4	22		HEX NUT	Nº 6-32 UNC-2B
		21			
	6	20		LOCKWASHER	3/8"
	4	19		LOCKWASHER	Nº 6
		18			
	11	17		SOC HD CAP SCREW	1/4"-20 UNC-2A x 1.00" LG
		16		SOC HD CAP SCREW	1/4"-20 UNC-2A x .75" LG
	6	15		HEX CAP SCREW	3/8"-16 UNC-2A x 1.00" LG
		14		SOC SET SCREW	1/4"-20 UNC-2A x .50" LG
	4	13		RD HD SCREW	Nº 6-32 UNC-2A x .75" LG
		12			
		11			
	1	10	SEE NOTE 1.	BACKER BAR	Nº 153076 -120"
	1	9	SEE NOTE 1.	TRANSDUCER	MODEL 1110 -120"
	1	8	SEE NOTE 1.	DIGITAL READOUT	MODEL 4051 EMP
		7			
2		6		END BRACKET	AISI 1020 HFS -.38" x 2.50"
1		5		ANGLE	ASTM-A36 HFS-3.0" x 3.0" x .25"
		4			
	1	3	-	BRACKET	ASTM-A36 HFS -2.0" x 2.0" x .25"
~	1	2		BRACKET WELDMENT	
	~	1		INSTALLATION	
QTY					

LIST OF MATERIAL

TOLERANCES ON			
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC	ANGLES
± .1	± .03	± .010	± 0° 30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .002 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

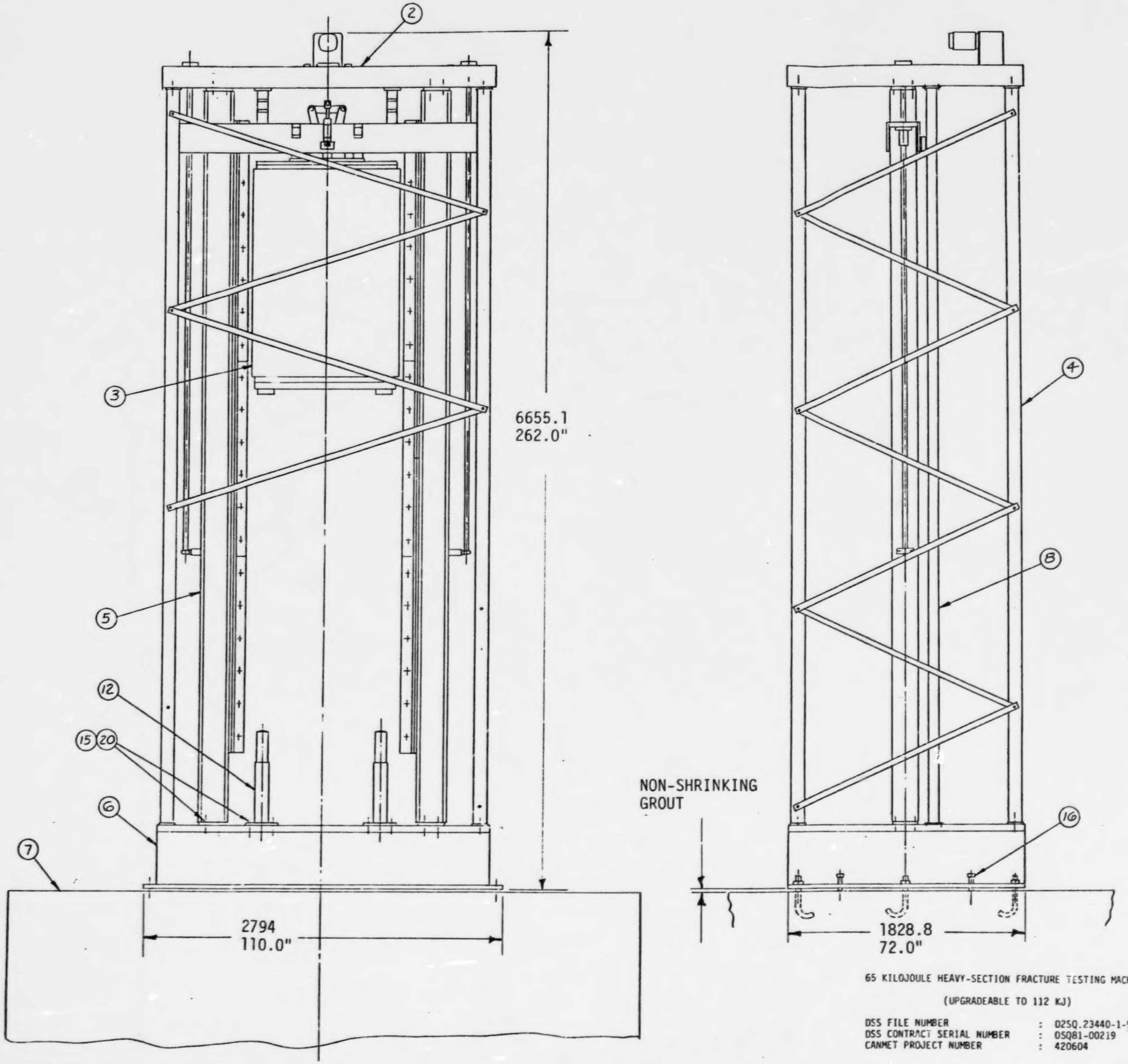
SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
LINEAR TRANSDUCER
INSTALLATION

DRAWN	DRAWING NO.	REV
MAR 27-83 Tellefson	2016	
CHECKED		
SCALE HALF & NOTED	WEIGHT -	OF

1. QUALITY MEASUREMENT SYSTEMS
2555 BAIRD ROAD, PENFIELD NEW YORK 14526

NOTES:



65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00219
CANMET PROJECT NUMBER	:	420604

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	26			
	25			
	24			
	23			
	22			
	21			
20	20		LOCKWASHER	3/4"
	19			
	18			
	17			
4	16		HEX CAP SCREW	1"-8 UNC-2A x 4.0" LG
20	15		HEX CAP SCREW	3/4"-10 UNC-2A x 2.0" LG
	14			
	13			
2	12		SHOCK ABSORBER-MOD 4x8	TAYLOR DEVICES Nº 6TSS-12583-010
	11			
	10			
	9	2019	TUP & ANVIL INSTALLATION	
1	8	2016	LINEAR TRANSDUCER	INSTALLATION
1	7	2015	FOUNDATION	
1	6	2014	BASE WELDMENT	
2	5	2012	COLUMN ASSEMBLY	
1	4	2011	STIFFENER FRAME	
1	3	2018	HAMMER ASSEMBLY	
1	2	2001	HOIST MECHANISM	
	1	2017	ASSEMBLY	

LIST OF MATERIAL

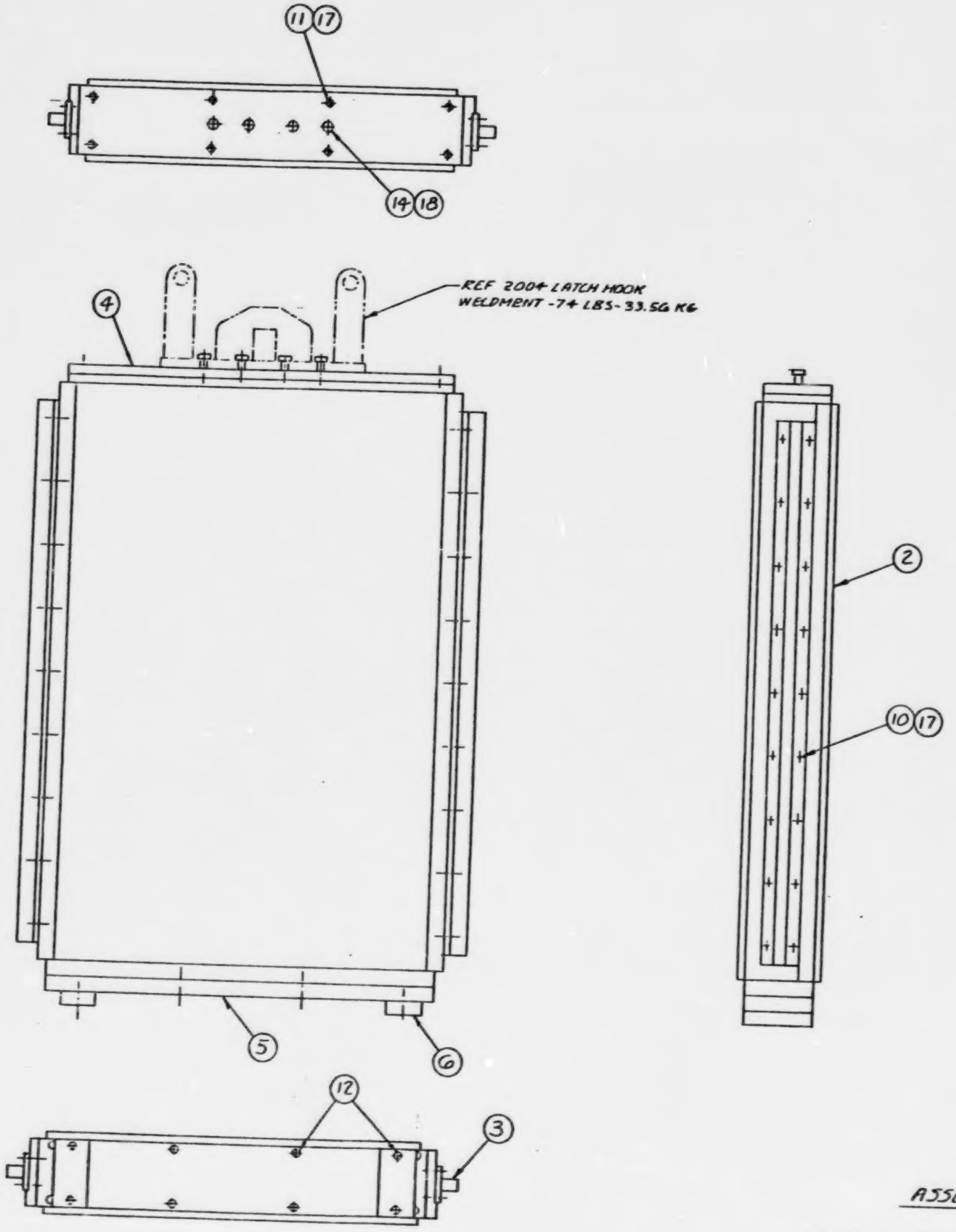
TOLERANCES ON			
1 PLACE DEC.	2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .002 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

TITLE
FRACTURE TESTING
MACHINE ASSEMBLY

DRAWN APRIL 7-83 T. Ilk[illegible]
CHECKED
SCALE SIXTEENTH
DRAWING NO. 2017
REV
WEIGHT
OF



65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER	:	02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER	:	0SQ81-00219
CANMET PROJECT NUMBER	:	420604

ASSEMBLY WEIGHTS (EXCLUDING TUP)

Nº OF CAVITIES FILLED	HAMMER ASSEMBLY WEIGHT
TWO	5823 LBS - 2641 KG
FOUR	8703 LBS - 3948 KG
FIVE	10143 LBS - 4601 KG

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	20			
	19			
4	18		LOCKWASHER	3/4
44	17		LOCKWASHER	1/2
	16			
	15			
4	14		HEX CAP SCREW	3/4"-10 UNC-2A × 2.0 LG
	13			
12	12		SOC HD CAP SCREW	1/2"-13 UNC-2A x 2.0 LG
8	11		HEX CAP SCREW	1/2"-13 UNC-2A x 2.0 LG
36	10		HEX CAP SCREW	1/2"-13 UNC-2A x 1.5" LG
	9			
	8			
	7			
2	6	2010-6	STRIKER	12.75 LBS - 5.78 KG EACH
1	5	2010-5	BOTTOM PLATE	159.7 LBS - 72.44 KG
1	4	2010-4	TOP PLATE	91.3 LBS - 41.41 KG
2	3	2010-1	GUIDE WELDMENT	83.4 LBS - 37.83 KG EACH
1	2	2009	HAMMER WELDMENT	
	1	2018	HAMMER ASSEMBLY	

LIST OF MATERIAL

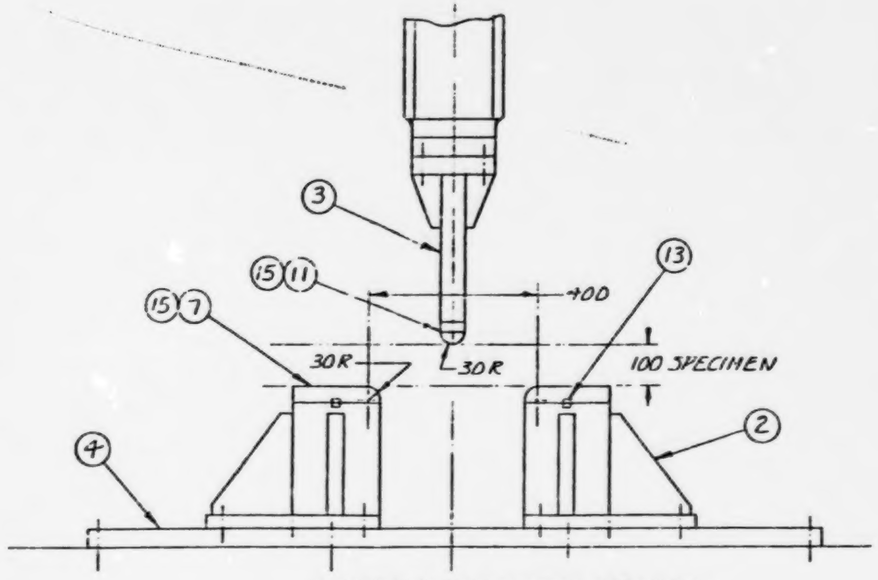
TOLERANCES ON			
1 PLACE DEC.	2 PLACE DEC	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS PER MIL-STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.020.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX OF .010 INCHES FOR A SINGLE SURFACE.

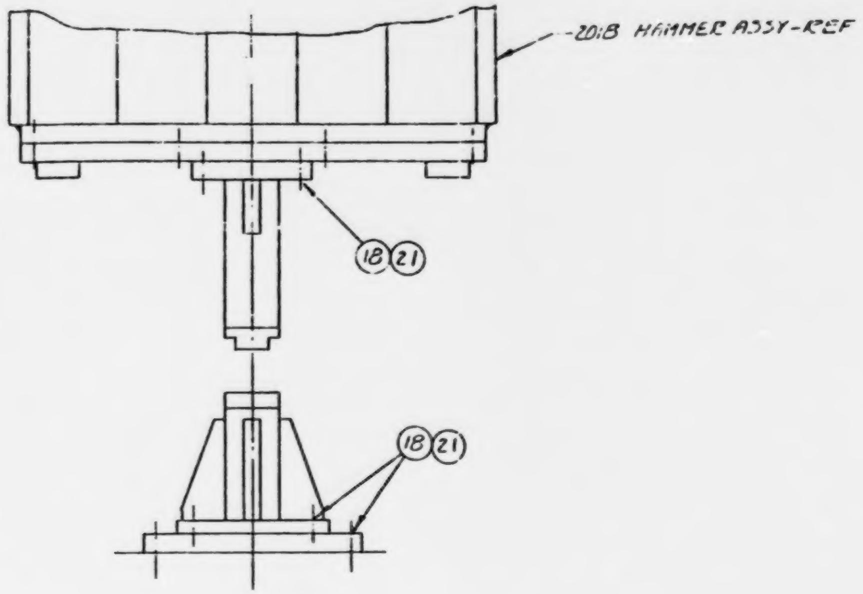
SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

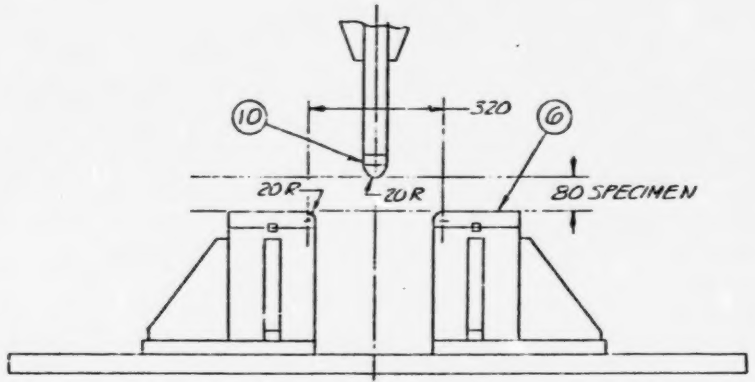
TITLE
HAMMER ASSEMBLY

DRAWN APR 9-83 Tellefsen
CHECKED
SCALE EIGHTH
DRAWING NO. 2018
REV
WEIGHT
OF

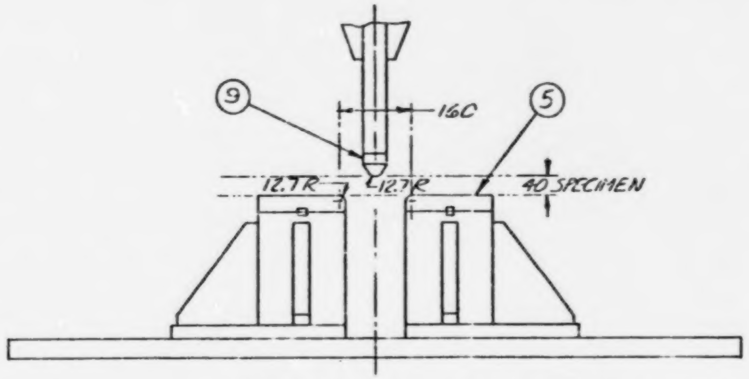


ASSEMBLY FOR 100MM SPECIMEN

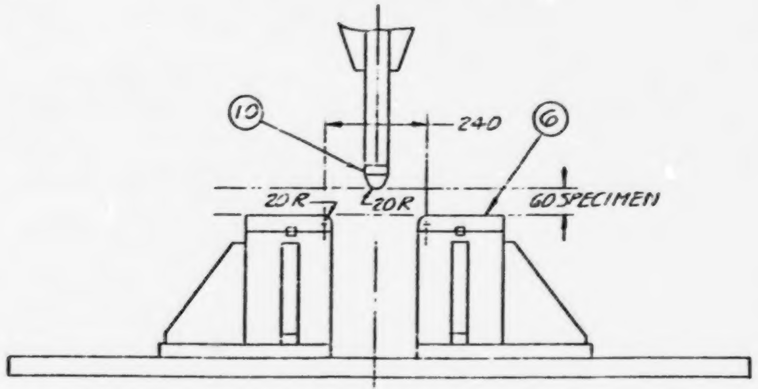




ASSEMBLY FOR 80 MM SPECIMEN



ASSEMBLY FOR 40 MM SPECIMEN



ASSEMBLY FOR 60 MM SPECIMEN

65 KILOJOULE HEAVY-SECTION FRACTURE TESTING MACHINE

(UPGRADEABLE TO 112 KJ)

DSS FILE NUMBER : 02SQ.23440-1-9069
DSS CONTRACT SERIAL NUMBER : 0SQ81-00219
CANMET PROJECT NUMBER : 420604

QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
	24			
	23			
	22			
24	21		LOCKWASHER	3/4
	20			
	19			
24	18		HEX CAP SCREW	3/4-10 UNC-2A × 3.0 LG
	17			
	16			
10	15		SOC HD CAP SCREW	1/2-13 UNC-2A × 1.5 LG
	14			
2	13		KEY	AISI 1018 CFS-.75 SQ × 3.0 LG
	12			
1	11	2020-11	TUP INSERT-30 R	
1	10	2020-10	TUP INSERT-20 R	
1	9	2020-9	TUP INSERT-12.7R	
	8			
2	7	2020-7	ANVIL INSERT-30 R	
2	6	2020-6	ANVIL INSERT-20 R	
2	5	2020-5	ANVIL INSERT-12.7R	
1	4	2020-4	BASE PLATE	
1	3	2020-3	TUP BASE WELDMENT	
2	2	2020-2	ANVIL BASE WELDMENT	
	1	2019	INSTALLATION	

LIST OF MATERIAL

TOLERANCES ON

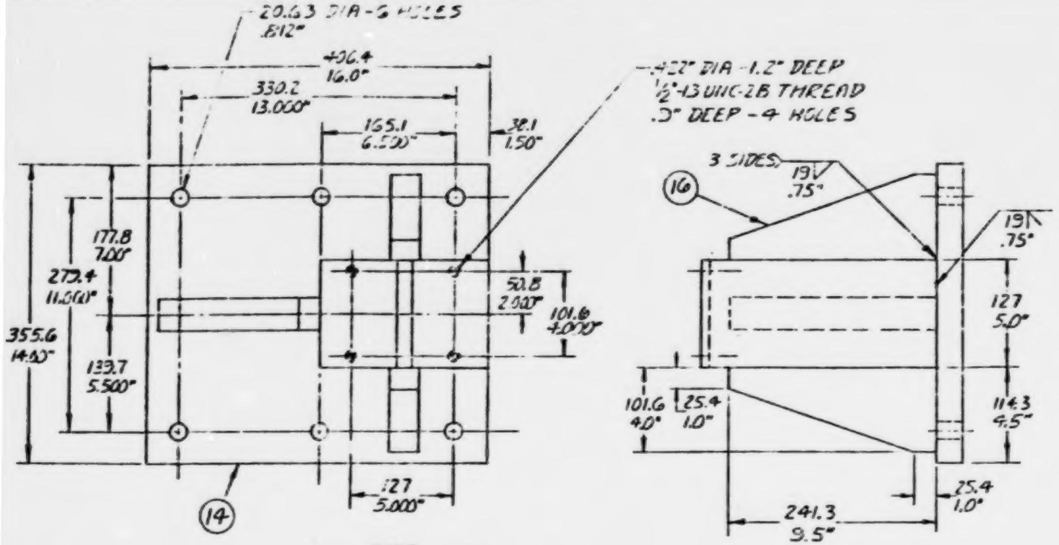
1 PLACE DEC	2 PLACE DEC	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0° 30'

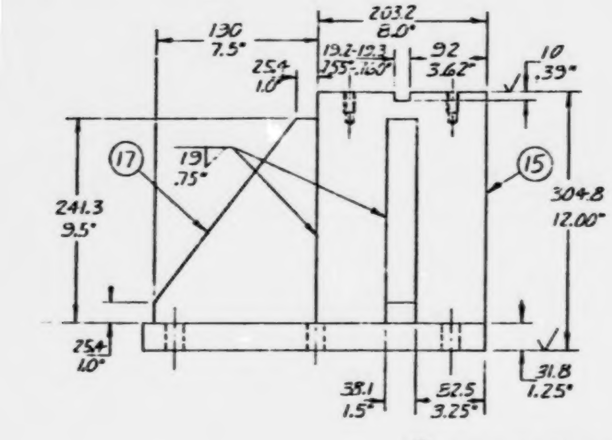
1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS PER MIL-STD-10
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .006 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .030 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

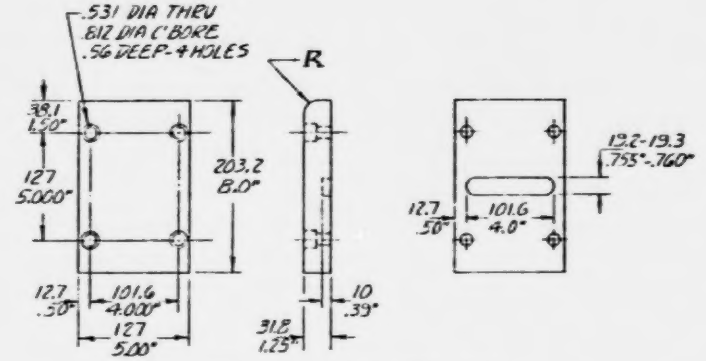
TITLE
INSTALLATION
TUP AND ANVIL

DRAWN Jun 14.83 Tollefson
CHECKED
SCALE
DRAWING NO. 2019
REV
WEIGHT
OF


20.63 DIA - 6 HOLES .812"
406.4 16.0"
330.2 13.000"
165.1 6.500"
38.1 1.50"
.422" DIA - 1.2" DEEP ½"-13 UNC-2B THREAD .9" DEEP - 4 HOLES
177.8 7.00"
279.4 11.000"
355.6 14.00"
139.7 5.500"
50.8 2.000"
101.6 4.000"
127 5.000"
(14)
3 SIDES
19 .75"
(16)
127 5.0"
101.6 4.0"
25.4 1.0"
114.3 4.5"
241.3 9.5"
25.4 1.0"


130 7.5"
203.2 8.0"
25.4 1.0"
19.2-19.3 .755-.760"
92 3.62"
10 .39"
(17)
19 .75"
(15)
241.3 9.5"
304.8 12.00"
25.4 1.0"
38.1 1.5"
82.5 3.25"
31.8 1.25"

② ANVIL BASE WELDMENT

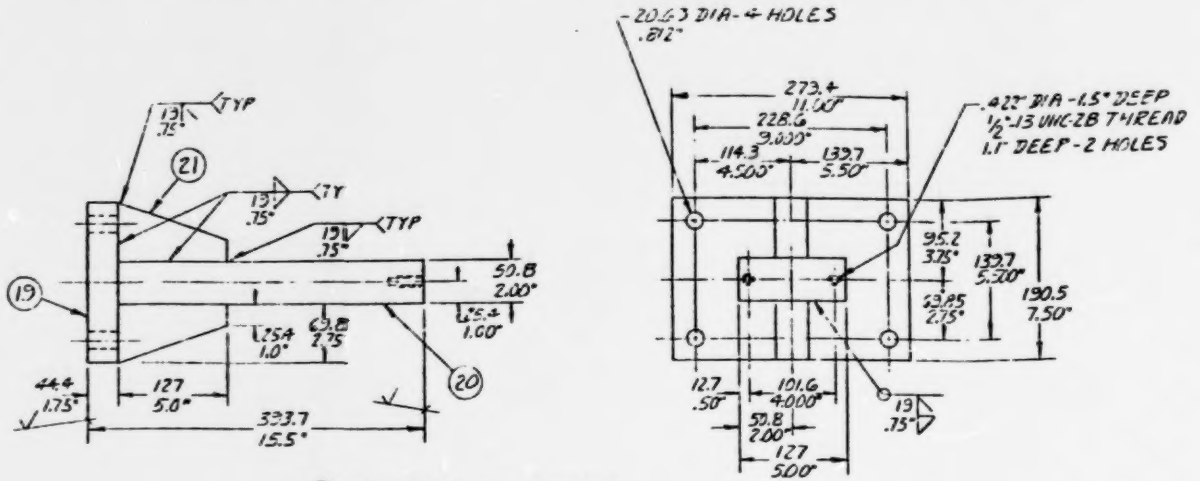

.531 DIA THRU .812 DIA C'BORE .56 DEEP - 4 HOLES
R
38.1 1.50"
127 5.000"
203.2 8.0"
12.7 .50"
101.6 4.000"
127 5.00"
31.8 1.25"
10 .39"
19.2-19.3 .755-.760"
12.7 .50"
101.6 4.0"

⑤ ANVIL INSERT - R = 12.7 - .50"

⑥ ANVIL INSERT - R = 20 - .787"

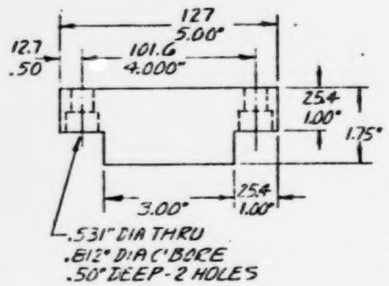
⑦ ANVIL INSERT - R = 30 - 1.181"

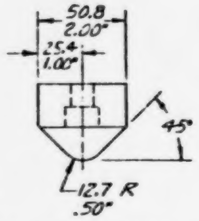
HEAT TREAT TO ROCKWELL C-58 TO C-62


13 .75" TYP
(21)
19 .75" TY
19 .75" TYP
(19)
50.8 2.00"
25.4 1.00"
25.4 1.0"
69.8 2.75"
44.4 1.75"
127 5.0"
393.7 15.5"
(20)
20.63 DIA - 4 HOLES .812"
273.4 11.00"
228.6 9.000"
114.3 4.500"
139.7 5.50"
.422" DIA - 1.5" DEEP ½"-13 UNC-2B THREAD 1.1" DEEP - 2 HOLES
95.2 3.75"
139.7 5.500"
69.85 2.75"
190.5 7.50"
12.7 .50"
101.6 4.000"
50.8 2.00"
127 5.00"
13 .75"

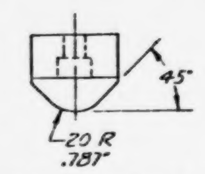
③ TUP BASE WELDMENT

NOTE: INSTRUMENTATION DETAILS NOT SHOWN

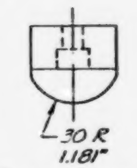

127 5.00"
12.7 .50
101.6 4.000"
25.4 1.00"
1.75"
3.00"
25.4 1.00"
.531" DIA THRU .812" DIA C'BORE .50" DEEP - 2 HOLES


50.8 2.00"
25.4 1.00"
45°
12.7 R .50"

⑨ TUP INSERT - 12.7R

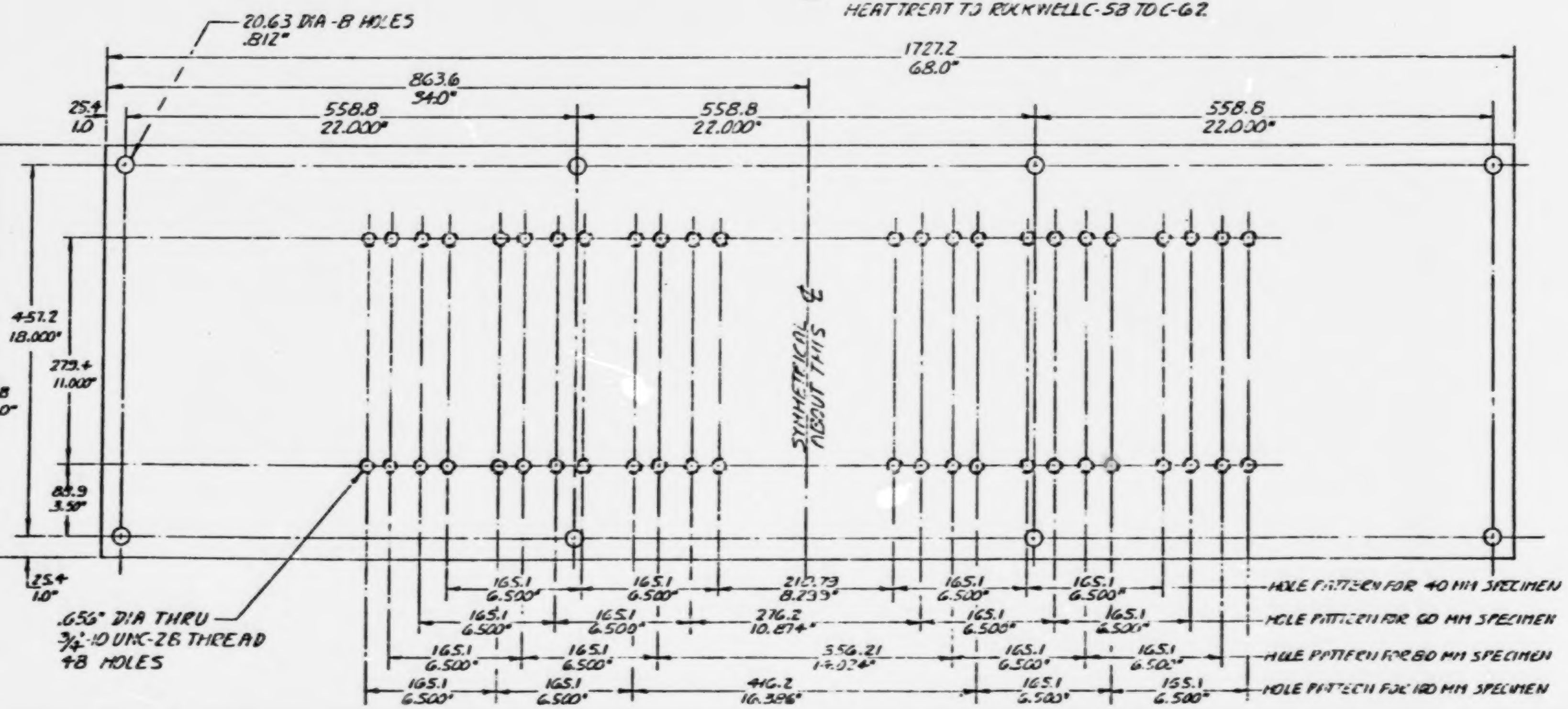


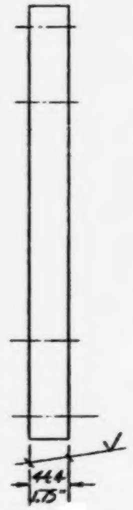
⑩ TUP INSERT - 20 R



⑪ TUP INSERT - 30 R

SCALE - HALF


20.63 DIA - 8 HOLES .812"
1727.2 68.0"
863.6 34.0"
25.4 1.0
558.8 22.000"
558.8 22.000"
558.8 22.000"
457.2 18.000"
279.4 11.000"
88.9 3.50"
25.4 1.0"
SYMMETRICAL ABOUT THIS ℄
.656" DIA THRU ¾"-10 UNC-2B THREAD 48 HOLES
165.1 6.500"
165.1 6.500"
210.73 8.299"
165.1 6.500"
165.1 6.500"
HOLE PATTERN FOR 40 MM SPECIMEN
165.1 6.500"
165.1 6.500"
276.2 10.874"
165.1 6.500"
165.1 6.500"
HOLE PATTERN FOR 60 MM SPECIMEN
165.1 6.500"
165.1 6.500"
356.21 14.024"
165.1 6.500"
165.1 6.500"
HOLE PATTERN FOR 80 MM SPECIMEN
165.1 6.500"
165.1 6.500"
416.2 16.386"
165.1 6.500"
165.1 6.500"
HOLE PATTERN FOR 100 MM SPECIMEN



④ BASE PLATE

		QTY	ITEM	PART NUMBER	DESCRIPTION	SPECIFICATION
			24			
			23			
			22			
2			21		GUSSET	ASTM-A36 HFS - 1.50 THICK
1			20		VERTICAL	AISI 1020 HFS - 2.00 × 5.00
1			19		BASE	ASTM-A36 HFS - 2.00 THICK
			18			
	1		17		GUSSET	ASTM-A36 HFS - 1.50 THICK
	2		16		GUSSET	ASTM-A36 HFS - 1.50 THICK
	1		15		VERTICAL	ASTM-A36 HFS - 5.00 THICK
	1		14		BASE	ASTM-A36 HFS 4.50 THICK
			13			
			12			
			11		TUP INSERT 30 R	TOOL STEEL-AISI-O2 2.0 THICK
			10		TUP INSERT 20 R	TOOL STEEL-AISI-O2 2.0 THICK
			9		TUP INSERT 12.7R	TOOL STEEL-AISI-O2 2.0 THICK
			8			
			7		ANVIL INSERT 30 R	TOOL STEEL-AISI-O2 1.5 THICK
			6		ANVIL INSERT 20 R	TOOL STEEL-AISI-O2 1.5 THICK
			5		ANVIL INSERT 12.7R	TOOL STEEL-AISI-O2 1.5 THICK
			4		BASE PLATE	ASTM-A36 HFS - 2.00 THICK
	~		3	2020-3	TUP BASE WELDMENT	
		~	2	2020-2	ANVIL BASE WELDMENT	
			1			

LIST OF MATERIAL

TOLERANCES ON			
1 PLACE DEC.	2 PLACE DEC	3 PLACE DEC.	ANGLES
± .1	± .03	± .010	± 0°-30'

1. DIMENSIONS ARE IN INCHES.
2. REMOVE BURRS AND SHARP EDGES .015 MAX.
3. ALL SURFACE ROUGHNESS (PER MIL-STD-10)
4. DIMENSION LIMITS HELD AFTER PLATING.
5. MACHINED FILLET RADII .015-.030.
6. MACHINED DIAMETERS ON A COMMON CENTERLINE MUST BE CONCENTRIC WITHIN .005 T.I.R. UNMACHINED DIAMETERS CONCENTRIC WITHIN .032 T.I.R.
7. NORMALITY, SQUARENESS AND PARALLELISM OF MACHINED SURFACES .002 PER INCH, TO A MAX. OF .012 INCHES FOR A SINGLE SURFACE.

SASKATCHEWAN RESEARCH COUNCIL
SASKATOON SASKATCHEWAN

TITLE
DETAILS
TUP AND ANVIL

DRAWN JUN 15-83 Tollefson
CHECKED
SCALE 1/4 EXCEPT AS NOTED
DRAWING NO. 2020
REV
WEIGHT
OF

5. SUMMARY OF RECOMMENDED OFF THE SHELF COMPONENTS AND PREFERRED SUPPLIERS, PLUS KEY REFERENCE LITERATURE DESCRIPTION

RECOMMENDED "OFF-THE-SHELF" COMPONENTS

ITEM		SUPPLIER
1.	2 of, DUFF NORTON No. DM-2811 INVERTED ROTATING BALL SCREW JACTUATOR UNIT with 144" screws	The Canadian DUFF-NORTON Company Ltd. 15 Lockport Avenue TORONTO, Ontario M8Z 2R6
	2 of, DUFF-NORTON No. SK-2409 flex-rigid-gear type flexible coupling	(416) 239-3525
	1 of, DUFF-NORTON No. SK-6000-C-40 rotary limit switch	
	1 of, DUFF-NORTON No. SK-6200-T-40 position transducer	
	1 of, DUFF-NORTON No. SK-6300 visual position indicator (console mounted) (see SRC dwgs 2001, 3001, 3002)	
2.	1 of, QMS Model EMP digitial readout	QUALITY MEASUREMENT SYSTEMS CORP. 2555 Baird Road
	1 of, QMS Model 1110 - 120 " transducer	Penfield, New York 14526 (716) 385-3848 (David Rucinski)
	1 of, QMS Model 153076 - 120" backer bar (see SRC dwg 2016)	
3.	1 of, ALLEN BRADLEY No. 800H-PP16 PLUS 800H - N1048 COLOR CAP ASSEMBLY, PILOT LIGHT, BLUE, 115 VAC, 60 HZ, SADDLE CLAMP TERMINAL, PANEL MOUNT	ALLEN-BRADLEY CANADA 135 Dundas Street CAMBRIDGE, Ontario N1R 5X1 (519) 623-1810
	10 of, ALLEN BRADLEY, No. 800H-PP16 PLUS 800H-N104A COLOR CAP ASSEMBLY, PILOT LIGHT, AMBER, 115 VAC, 60 HZ, SADDLE CLAMP TERMINAL, PANEL MOUNT	
	1 of, ALLEN BRADLEY No. 800H-PP16 PLUS 800H-N104G COLOR CAP ASSEMBLY, PILOT LIGHT, GREEN, 115 VAC, 60 HZ, SADDLE CLAMP TERMINAL, PANEL MOUNT	
	3 of, ALLEN BRADLEY No. 800H-PPF16R FLASHING PILOT LIGHT, RED, 115 VAC, 60 HZ, SADDLE CLAMP TERMINAL, PANEL MOUNT	

RECOMMENDED "OFF-THE-SHELF" COMPONENTS (continued)

ITEM	SUPPLIER
3. (continued) 6 of, ALLEN BRADLEY No. 800H-AP9B, MOMENTARY CONTACT PUSH BUTTON, SADDLE CLAMP TERMINAL, 2 N-O/ 2 N-C, 115 VAC, 60 HZ, FLUSH HEAD, YELLOW PANEL MOUNT	
2 of, ALLEN BRADLEY No. 800H-DP6H, MOMENTARY CONTACT PUSH BUTTON, SADDLE CLAMP TERMINAL 3 N-O/ 3 N-C, 115 VAC, 60 HZ, MUSHROOM HEAD, RED PANEL MOUNT	
8 of, ALLEN BRADLEY No. 800H-AP1H, MOMENTARY CONTACT PUSH BUTTON, SADDLE CLAMP TERMINAL, 3 N-O/ 3 N-C, 115 VAC, 60 HZ, FLUSH HEAD, GREEN PANEL MOUNT	
2 of, ALLEN BRADLEY No. 800H-AP2A, MOMENTARY CONTACT PUSH BUTTON, SADDLE CLAMP TERMINAL, 1 N-O/ 1 N-C, 115 VAC, 60 HZ, FLUSH HEAD, BLACK PANEL MOUNT (see SRC dwgs 3001 and 3002)	
4. 1 of, COLE HERSEE No. 551840 EXTRA HEAVY DUTY DIE CAST TOGGLE SWITCH, CHROME PLATED, LONG BAT HANDLE, 2 POSITION - ON - OFF, S.P.S.T., PANEL MOUNT (see SRC dwg 3001 and 3002)	COLE HERSEE CO. 20 Old Colony Avenue South Boston, Ma. 02127 (617) 268-2190
5. 1 of, MALLORY No. SC110MJ INTERMITTENT TONE BUZZER, 115 VAC, 60 HZ, 95dB(A) SOUND PRESSURE AT TWO FEET, SLOW PULSE AT 1.5 PULSES PER SECOND, PANEL MOUNT (see SRC dwg 3001 and 3002)	CAM GUARD SUPPLY 88 Horner Avenue TORONTO, Ontario (416) 252-5031
6. 13 of, POTTER AND BRUMFIELD relay, #KRP14AG, 120 V, 3PDT (see SRC dwg 3001 and 3002)	AMF P.O. Box 3620 GUELPH, Ontario N1H 7H1 (519) 822-1576

RECOMMENDED "OFF-THE-SHELF" COMPONENTS (continued)

ITEM	SUPPLIER
7. 1 of, air cylinder as per SRC dwg 2006-1 1 of, air cylinder as per SRC dwg 2006-2 1 of, air cylinder as per SRC dwg 2006-3	AEROQUIP TOMKINS-JOHNSON DIVISION 287 Bridgeland Avenue TORONTO, Ontario M6A 1Z7 (416) 781-5261
8. 3 of, PARKER single 4-Way, 5-Port, 2-Position Double Solenoid Valve, Model No. 4501A S10 A AAA53 with PARKER SP-25 port flow controls in valve ports 3 and 5 2 of, PARKER FRL Assembly Three-Unit Combination No. 04A11B18E0B	PARKER FLUID POWER 5935 Ambler Drive MISSISSAUGA, Ontario L4W 2K2 (416) 624-3710
9. 1 of, Mannesmann Demag, Main Motor No. KB(A) 112MA, 100% Duty Factor, 575V, 3 phase, 60 Hertz 1 of, Mannesmann Demag, intermediate gear box, size FG08, ratio 10:1 1 of, Mannesmann Demag, Micromotor No. KB(A) 71A, 100% Duty Factor, 575V, 3 phase, 60 Hertz 3 of, Mannesmann Demag motor couplings, No. H2N-28 (see SRC dwg 2001)	MANNESMANN DEMAG LTD. Material Handling Division 2400 Royal Windsor Drive MISSISSAUGA, Ontario L5J 1K1 (416) 823-4500 (Zsalt J. Villanyi)
10. 1 of, HUB CITY Model 828, 1:1 ratio, Bevel Gear Drive (see SRC dwg 2001)	HUB CITY POWER TRANSMISSION DIVISION Safeguard Automotive Corporation P.O. Box 1089 ABERDEEN, South Dakota 57401 (605) 225-0360 (Gerry Newharth)

RECOMMENDED "OFF-THE-SHELF" COMPONENTS (continued)

	ITEM	SUPPLIER
11.	2 of, TAYLOR DEVICES 4" dia x 8" stroke liquid spring shock (see SRC dwg 2017)	TAYLOR DEVICES INC. 200 Michigan Avenue North Tonawanda, New York 14120 (716) 694-0800 SEE TAYLOR DEVICES Proposal No. 1278382 of December 22, 1982 (Ross McCulloch)
12.	604 MACHINE BOND epoxy resin grout; approx. 10 cubic feet poured (see SRC dwg 2017)	CARTER-WATERS CORP. 2440 W. Pennway Box 19676 Kansas City, Missouri 64141 (816) 471-2570 (Bob Rhea)
13.	GARLOCK 0.030" thickness MULTIFIL 426 BEARING TAPE (see SRC dwg 2013)	GARLOCK BEARINGS INC. 700 Mid Atlantic Parkway Thorofare, New Jersey 08086 (609) 848-3200 (Stan Ordo)
14.	2 of, DODGE No. SC-1" shaft pillow block assembly (see SRC dwg 2001)	DODGE Canada 296 Walker Drive BRAMALEA, Ontario L6T 4B3 (416) 792-1739
15.	6 of, LEE No. LC-047F-9 spring (see SRC dwg 2002)	LEE SPRING CO. 30 Main Street Brooklyn, N.Y. 11201 (212) 236-2222
16.	Various fasteners i.e. nuts, bolts, washers, etc. as per SRC dwgs, all grade five unless noted otherwise	no preference
17.	All other material as required (excluding Section 2 hardware)	no preference

KEY REFERENCE LITERATURE REQUIRED	AVAILABLE FROM
1. DUFF-NORTON MECHANICAL ACTUATORS DESIGN GUIDE, CATALOG 172	The Canadian Duff-Norton Company Ltd. 15 Lockport Avenue TORONTO, Ontario M8Z 2R6 (416) 239-3525
2. QUALITY MEASUREMENT SYSTEMS Transducer Installation Instruction, 154108	
OPERATING INSTRUCTIONS FOR DIGITAL ELECTRONIC INSPECTION STATION EQUIPMENT	QUALITY MEASUREMENT SYSTEMS, INC. 2555 Baird Road PENFIELD, New York 14526 (716) 385-3848
3. ALLEN-BRADLEY INDUSTRIAL CONTROL HANDY CATALOG No. 30	ALLEN-BRADLEY CANADA 135 Dundas Street CAMBRIDGE, Ontario N1R 5X1 (519) 623-1810
4. Cole Hersee MASTER CATALOG Form No. D-270	Cole Hersee 20 Old Colony Avenue BOSTON, Mass. 02127 (617) 268-2190
5. CAM GARD SUPPLY, CATALOGUE 582	CAM GARD SUPPLY 88 Horner Avenue TORONTO, Ontario M8Z 5Y3 (416) 252-5031
6. AMF Potter and Brumfield Distributor Stock Relays, Catalogue 100C	AMF P.O. Box 3620 GUELPH, Ontario N1H 7H1 (519) 822-1576
7. Aeroquip T-J Series S Air, Series LS Hydraulic Cylinders, CATALOG 4063	AEROQUIP CORPORATION 287 Bridgeland Avenue TORONTO, Ontario M6A 1Z7 (416) 781-5261
8. Parker Fluidpower Air Control Valves and Air Preparation Units, Catalog 0600	Parker Hannifin Corporation Pneumatic Division 601 South Wilmott OTSEGO, Michigan 49078 (616) 694-9411
9. MANNESMANN DEMAG Industrial Drives Catalogue 2.81 701 IS 900 Drives coupling data	Mannesmann Demag Ltd. Material Handling Division 2400 Royal Windsor Drive MISSISSAUGA, Ontario L5J 1K7 (416) 823-4500

10.	GUERTIN BROS. PRODUCT DATA SHEETS on a) Aluminum Moisture Cure Primer, CODE SP 3541 UPC-6-001 b) plastic top coat, CODE UTC-2	GUERTIN BROS. COATING AND SEALANTS LTD. 270 Assiniboine Avenue WINNIPEG, Manitoba R3C 0X6 (204) 947-0491
11.	1982 CANADIAN ELECTRICAL CODE PART I CSA C22.1 - 1982 Electrically-Equipped Machine Tools CSA C22.2 No. 73-1953 (R1965)	Canadian Standards Association 178 Rexdale Boulevard REXDALE, Ontario M9W 1R3 (416) 744-4044
12.	HUB CITY ENGINEERING MANUAL NO. 1	POWER TRANSMISSION DIVISION SAFEGUARD AUTOMOTIVE CORPORATION P.O. Box 1089 ABERDEEN, South Dakota 57401 (605) 225-0360
13.	SAE J 833(JAN 80) USA HUMAN PHYSICAL DIMENSIONS	1983 SAE Handbook, Part 4 Published by: Society of Automotive Engineers, Inc. 400 Commonwealth Drive WARRENDALE, Pa 15096 (412) 776-4841
14.	TAYLOR DEVICES INC. SHOKS catalog & Designers Guide to Hydraulic Shock Absorber Selection	TAYLOR DEVICES INC. NORTH TONAWANDA, New York 14120 (716) 694-0800
15.	CARTER WATERS 604 MACHINE BOND EPOXY RESIN GROUT APPLICATION BROCHURE	CARTER WATER CORP. 2440 W. Pennway Box 19676 Kansas City, Missouri 64141 (816) 471-2570
16.	GARLOCK BEARINGS MULTIFIL 426 BEARING TAPE APPLICATION BROCHURE	GARLOCK BEARINGS INC. 700 Mid Atlantic Parkway Thorofare, New Jersey 08086 (609) 848-3200

6. FOUNDATION RECOMMENDATIONS

6. FOUNDATION RECOMMENDATIONS

FOUNDATION RECOMMENDATIONS

This section describes our recommended arrangement for the CANMET fracture testing machine. This DSS contract no. OSQ81-00219 did not include an analysis by SRC of the specific soil conditions at the proposed testing machine site. In view of this our recommended arrangement is conceptual only, and does not represent a finished foundation design. Sections 6.4 and 7 from the END OF PHASE ONE REPORT (SRC Public. No. I-4304-1-C-82) discuss the need for knowing local soil conditions.

The CANMET Drop Weight System is specially designed to provide maximum protection for the instrumented tup and the test specimen. This protection is required to prevent overloading of the instrumented tup after fracture of the test specimen and multiple impact upon the test specimen caused by the rebound of the hammer. The design consists of a hammer excess energy absorption system which absorbs the hammer excess energy and prevents hammer rebound. This design also minimizes the adverse shock which can be transmitted to the components of the tower assembly of this drop weight system. The drop weight system must be securely bolted to a rigid foundation (SRC DWG 2015), to permit maximum utilization of the design features and prevent damage to critical components.

The HAMMER EXCESS ENERGY ABSORPTION SYSTEM is sized as follows:

The minimum required impact testing machine capacity is

6,000 lbs. (hammer weight) x 8 feet (drop height) = 48,000 FT. LB.

$$\text{or} \quad 48{,}000 \text{ FT. LB.} \times \frac{1 \text{ Joule}}{0.7376 \text{ FT. LB.}} = 65075.922 \text{ JOULES} = 65 \text{ KILOJOULES}$$

This is as specified in APPENDIX "F" STATEMENT OF WORK from the January 13, 1983 CONTRACT AMENDMENT OF DSS CONTRACT SERIAL NUMBER: OSQ81-00219.

An energy absorption system is required to dissipate the excess drop weight (hammer) kinetic energy which remains after fracturing the test specimen.

For safety purposes an operator should be able to drop the weight from maximum drop height without a specimen in place. All the kinetic energy in the drop weight would then be absorbed by the energy absorption system.

We propose such an energy absorption arrangement based on the use of two mill service quality fluidic type shock absorbers, TAYLOR DEVICES 4" diameter x 8" stroke liquid spring shock, (see TAYLOR DEVICES Proposal No. 1278382 and SRC drawing 2017).

These liquid spring shocks absorb the impact energy of the drop weight and convert it to heat. After impact, the drop weight is reset and therefore removed from the shocks. Then internally mounted coil springs gently restore the buffers to their original unstroked condition.

Application Analysis

From the TAYLOR DEVICES SHOCK designers guide

$$\begin{aligned} KE &= W(H + S) \\ &= 6{,}000\left(8 + \frac{8}{12}\right) \\ &= 52{,}000 \text{ FT. LB.} \end{aligned}$$

where KE = kinetic energy (FT. LB.)
W = hammer weight (LB.)
H = vertical height (FT.)
S = shock absorber stroke (FT.)

also $KE_{max} = (0.9)(F)(S)$ where F = shock force rating (LB.)
S = shock absorber stroke (FT.)

As per the TAYLOR DEVICES proposal, F per shock = 50,000 LB.
S = 8"

Thus $KE_{max} = (0.9)(50{,}000)(\frac{8}{12}) \times 2$ of = 60,000 FT. LB.

As 60,000 > 52,000, the shocks are adequate

In the event of a hammer weight upgrading (see SRC drawing 2009), the shocks may become inadequate if it is still desired that the shocks be capable of absorbing all the energy of the upgraded drop weight from maximum drop height without a specimen in place on the anvils.

Decellerations over 2 g's are noisy, and there will be times when the decelleration rate is well above this. Therefore, we recommend that the operators wear ear plugs during the drop tests.

For this application we recommend a base weldment below grade foundation as illustrated by SRC concept drawing 2015. This is a poured-in-place reinforced concrete rectangular block, 16' square x 8' deep. It has a three dimensional grid of continuous length rebar in the X, Y, and Z planes.

If the adjacent grade is to consist of a poured-in-place concrete slab, we recommend that this slab be isolated from the foundation by anchoring a 1" thick (minimum) X slab depth (minimum) continuous length of high durometer polyurethane around the top perimeter of the foundation prior to pouring the surrounding slab.

CANMET should excavate for the foundation and evaluate soil conditions at this level to determine whether additional below foundation support will be necessary to prevent possible permanent displacement of the foundation. A conservative approach would be to drive H section steel beam piles in place at the -8' below grade level and pour the reinforced concrete block foundation on top of and around the driven piles.

The specification of foundation concrete type, strength and additives as necessary, rebar strength, grout type and strength[1] should be decided on by CANMET based on their evaluation of local soil conditions.

It is most important that the hammer drop in a vertical path and thereby minimize friction caused by inter-action with the guide posts. To assure this, the 2014 BASE WELDMENT must be installed accurately level. It should be shot in with a transit using the machined top surface as a level reference datum.

Drawing 2017 illustrates the installed BASE WELDMENT and FOUNDATION. The installation procedure would be:

1. Make sure that the BASE WELDMENT has been sandblasted on the bottom to bright metal and then degreased with an oilless solvent.
2. Using a crane, sling the BASE WELDMENT into place over the six 'J' bolts in the foundation.
3. Using the four of, levelling screws, raise the BASE WELDMENT to a level position with sufficient clearance allowed for grout installation. A 2" clearance has been recommended by Mr. Bob Rhea of the CARTER-WATERS CORP., 2440 W. Pennway, Box 19676, Kansas City, Missouri, 64141 (816) 471-2570. This based on using their 604 machine bond epoxy resin grout.

---

[1] Tentative selection of C-W 604 epoxy resin grout.

4. Build a trough form around the BASE WELDMENT at least 3" deep x 112" x 74" inside measurements.

5. Remove the BASE WELDMENT from the 'J' bolts. Make sure the top of the foundation is free of contaminants, dirt, etc. It should be rough textured.

6. Mix sufficient grout and fill the trough form to a depth sufficient to cause grout to rise above the bottom of the BASE WELDMENT perimeter when it is repositioned over the 'J' bolts.

7. Sling the BASE WELDMENT back into place, making sure it is still level.

8. Place a flat washer, lock washer and prevailing torque[1] hex locknut on each 'J' bolt.

9. Half torque[2] each centre 'J' bolt first, then each pair of diagonal bolts. Repeat sequence to full rating of nuts. Make sure BASE WELDMENT is still level. Steps 6 to 9 inclusive must be accomplished within the working time of the grout, approximately 3½ hours on average.

10. When grout has cured remove the trough form, and proceed with balance of testing machine assembly.

---

[1] Grade two nuts are sufficient to match the ASTM A36 'J' bolts.

[2] Half torque is one half the rated grade two prevailing torque nut assembly torque rating.

taylor DEVICES INC.
200 MICHIGAN AVENUE NORTH TONAWANDA, NEW YORK 14120
PHONE 716 694-0800

COMPRESSIBLE MATERIAL DEVICES

December 22, 1982

Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan S7N 0XI

Attn: Allan Malinoski

Dear A. Malinoski:

Enclosed is our Proposal No. 1278382 per your request.

If you require any further information, please contact me.

Sincerely,

TAYLOR DEVICES, INC.

Ross McCulloch

Ross McCulloch
Technical Sales Representative

RM/ck
Enc.

taylor DEVICES INC.

200 MICHIGAN AVENUE
NORTH TONAWANDA, NEW YORK 14120

PHONE
716-694-0800

Proposal No.: 1278382
Reference:

SPRING SHOKS – TIME DELAY SHOKS – DASHPOTS – SPRINGS – ACTUATORS – ACCUMULATORS

USING LIQUID COMPRESSIBILITY – A NEW ENERGY SOURCE

Proposed to:
Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan
S7N OXI

Initiated by: Ross McCulloch
Technical Sales Representative

Approved by: Douglas P. Taylor
Executive Vice President

For information on this Proposal Contact Applications Engineer and Reference Proposal Number: SALES

Attention: Allan Malinoski

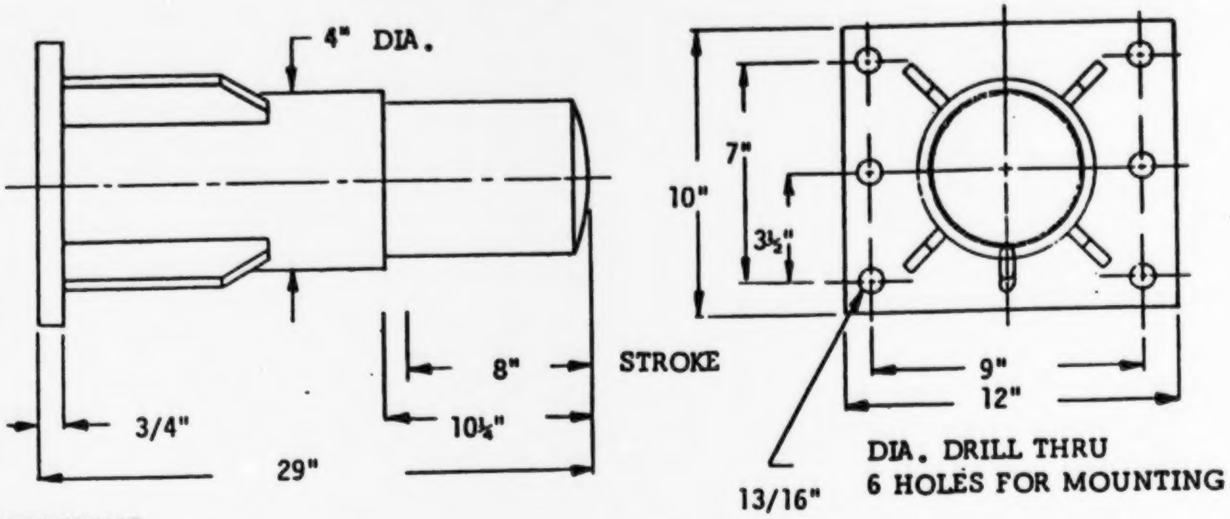
DATE	QUOTATION FIRM	F.O.B.	SALES OFFICE:	Terms:
12-22-82	FOR 90 DAYS	Origin	N. Tonawanda, N.Y.	2%-10 days Net 30 days

Item	Quantity	Description	Unit Price
			U S FUNDS
1	2 pc.	MODEL 4 x 8 Shock Absorber (With full capacity acceptance testing) P/N 67SS-12583-010	$1,772.00 ea. net

Initial quantity of ________ can be delivered ________ weeks after receipt of Purchase Order. Production quantities of ________ can be delivered each month following. Additional deliveries can be quoted on request.

EPARED FOR : Allan Malinoski 6-8
MPANY : Saskatchewan Research Council
DDRESS : 30 Campus Drive
TY & STATE : Saskatoon, Saskatchewan S7N 0X1
FERENCE :

PREPARED BY: Ross McCulloch
TAYLOR DEVICES, INC.
200 Michigan Avenue
North Tonawanda, New York



PECIFICATIONS:

1. This shock absorber is designed to absorb the energy of a 6,000 lb. weight free falling 8 feet. Total energy to be absorbed by 2 units.
2. Stroke 8 inches
3. Design backup structure for 50,000 lbs.
4. Buffer weight 75 lbs.

B/P COPY NO.____________________
B/P SUBJECT TO RECALL.
B/P AND SUBJECT MATTER PROPERTY
TAYLOR COMPANIES.
REPRODUCTION B/P OR SUBJECT
MATTER PROHIBITED.

PATENTS | Pending Applied For

Copyright 1956 Form 52

ATERIAL

Taylor Devices Inc.
PHONE 694-0800 NORTH TONAWANDA, N. Y.

Model 4 X 8 Shock Absorber
Saskatchewan Research Council

SIZE	CODE IDENT. NO.	DRAWING NO.
	06742	67SS-12583-010

SCALE. SHEET

Health Precautions

604 MACHINE BOND is a low toxicity system, however, any epoxy system may produce allergic reactions such as skin irritations or dermatitis in some persons. Persons handling 604 MACHINE BOND should avoid skin contact. Do not take internally. The use of rubber gloves, safety glasses, or goggles and other protective equipment and clothing is recommended. Contaminated areas of the body should be cleaned and scrubbed with soap and water. In case of contact with eyes, flood with water and see a physician immediately. Remove and wash contaminated clothing before reuse. Use in well-ventilated areas and avoid breathing fumes and dust. Do not use or mix near other chemicals.

Supplementary Materials

The following materials are available to aid in obtaining maximum results and aesthetic effect on 604 MACHINE BOND installations.

PC-700 Solvent...
a non-oil based, non-flammable liquid for cleaning tools, equipment, and concrete or metal surfaces.

604 Surface Spray...
a spray-applied liquid used to produce a smoother finish on 604 MACHINE BOND Grout.

440 Penetrating Sealer...
to be applied to damp concrete surfaces prior to grouting.

400-NS...
Protective/decorative epoxy coating to seal concrete surfaces against water and oil penetration and provide a uniform and neat concrete/grout bed appearance. Standard color "machinery gray" — other colors available on special order.

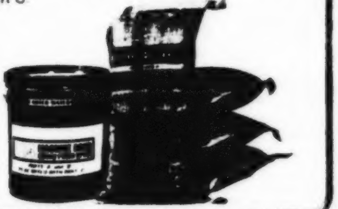
Other epoxy products are available for specific purposes. Consult our brochure "Epoxy Resin Compounds formulated by Carter-Waters."

Packaging

A Unit of 604 MACHINE BOND consists of liquids Part A and Part B in a five gallon (19 liter) two compartment metal container and four 50 pound (22.7 kilogram) bags of special aggregate, Part C.

Weight	236 pounds (107.05 kilograms)
Yield	2 cubic feet (0.057 cubic meters)
Specific Gravity	1.89
Freight Classification	Acid Proof Cement

Part A — Resin	480	248.9
Part B — Catalyst	450	232.2
Part C — Aggregate	None	None



WARRANTY

[illegible]

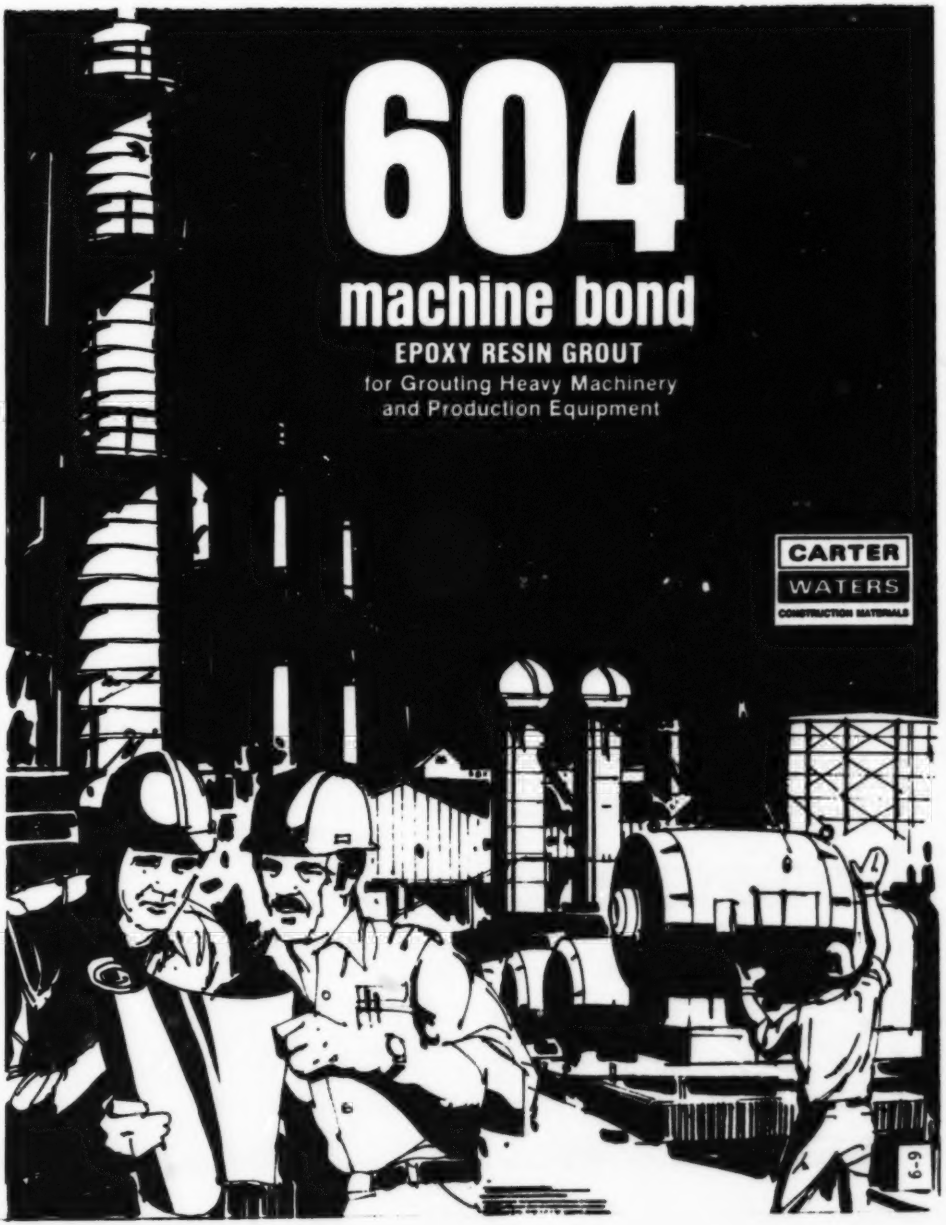
DISCLAIMER

Since the methods and conditions of application and use are beyond our control, manufacturer hereby expressly disclaims any warranty of MERCHANTABILITY, or FITNESS FOR A PARTICULAR PURPOSE. Further, the manufacturer expressly limits its liability to the purchase price hereof and expressly disclaims all liability for any actual, incidental, or consequential damages that may occur. THE PRECEDING DISCLAIMER OF WARRANTIES AND LIMITATION OF REMEDIES DO NOT APPLY TO PRODUCTS WHICH ARE THE SUBJECT OF CONSUMER TRANSACTIONS IN JURISDICTIONS WHERE SUCH DISCLAIMERS OR LIMITATIONS ARE PROHIBITED BY LAW. The preceding shall be excepted or modified when provisions have been made by the purchaser to purchase the exclusive warranty described under WARRANTY and subject to all conditions stated therein.

Distributed by:

604 MACHINE BOND epoxy resin grout

THE CARTER-WATERS CORPORATION
2440 W PENNWAY • BOX 19676 • KANSAS CITY MISSOURI 64141
PHONE 816-471-2570



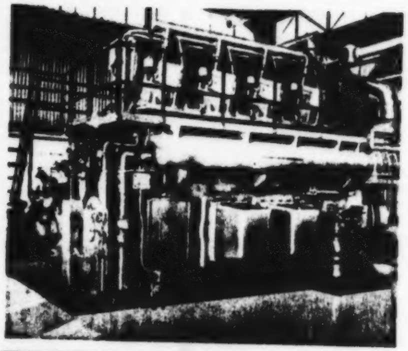
604 machine bond

EPOXY RESIN GROUT

for Grouting Heavy Machinery
and Production Equipment

CARTER
WATERS
CONSTRUCTION MATERIALS

Description



UNIQUE WARRANTY

604 MACHINE BOND [illegible] by a [illegible] installed in accordance with our "Specifications for Grouting Heavy Machinery and Production Equipment With No. 604 MACHINE BOND Epoxy Resin Grout," and under the guidance of a Carter-Waters Corporation grout technician. (See terms on last page of this brochure.)

604 MACHINE BOND is a three component epoxy resin grout which was developed for grouting heavy machinery, engines, and production equipment to resist vibration, chemical attack, high torque, and other stresses associated with such installations.

604 MACHINE BOND is composed of three components: two liquid components (Part A — Resin, Part B — Catalyst) and an aggregate (Part C). Parts A and B are compartmentalized in a five gallon pail and Part C is packaged in four 50 pound bags.

The three components, when mixed, produce a structural solid with impressive physical characteristics especially suited for heavy duty grouting purposes.

604 MACHINE BOND "Accelerated" formulation, or the Accelerator only (for addition to the non-accelerated formulation) is available when ambient temperatures are 50-70° F. (10-21.1° C.)

Uses

604 MACHINE BOND Epoxy Resin Grout should be used where high compressive, flexural and tensile strength, good chemical resistance, low exothermic chemical reaction, good flowability, and permanence are needed.

604 MACHINE BOND has been used successfully in a variety of installations such as: grouting heavy duty internal combustion engines; grouting production machinery such as presses, conveyors, mixers, scales, extruders, and electric motors; grouting commercial compressor units; grouting air and liquid moving equipment; and construction, renovation, and maintenance applications.

Advantages

604 MACHINE BOND Epoxy Resin Grout has special physical characteristics engineered into the system to assist in opposing horizontal and tangential forces as well as to provide vertical support to heavy duty machinery and equipment in operation. No other epoxy grout has as many unique advantages as 604 MACHINE BOND.

- HIGH FLEXURAL, SHEAR, TENSILE, and COMPRESSIVE STRENGTH combine to withstand a wide variety of destructive forces. See Table 1.
- DEEPER SINGLE POURS POSSIBLE due to low heat build-up during cure.
- NO AGGREGATE SEPARATION regardless of depth of pour.
- SUPERIOR HEAT RESISTANCE (up to 185° F., 85° C.) provides grout bed strength even under unusually high operating temperatures.
- SAFER HANDLING due to low toxicity.
- FLOWS EASILY for efficient placement and is SELF-LEVELING for positive grouting of inaccessible areas.
- EASY CLEAN-UP of tools and surfaces during plastic stage with water.
- HIGH CHEMICAL RESISTANCE after cure provides effective resistance to water, oil, salts, non-oxidizing acids, and most solvents.
- LONGER WORKING TIME facilitates proper placement.
- 50 POUNDS MAXIMUM WEIGHT PACKAGING complies with OSHA standards and makes for easy handling.

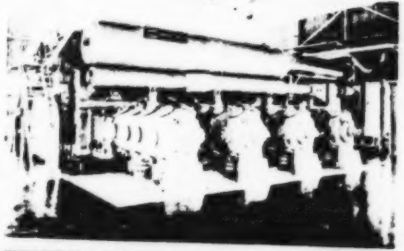
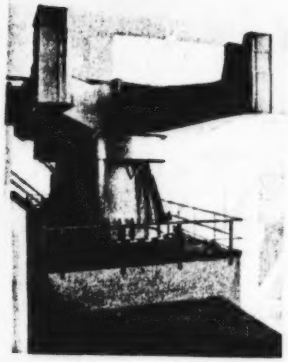


TABLE 1

Physical Properties of 604 Machine Bond Grout at 75° F. [illegible]

TEST		24 Hr. Cure			7 Day Cure		
		psi	Mega-pascals	kgf/cm²	psi	Mega-pascals	kgf/cm²
Compressive Strength		7,376	50.9	518.6	11,876	81.9	835
Flexural Strength		5,426	37.4	381.5	6,036	41.6	424.4
Tensile Strength		2,316	16	162.8	2,406	16.6	169.2
Single Shear Strength		3,066	21.1	215.6	3,353	23.1	235.7
Double Shear Strength		3,130	21.6	220.1	3,380	23.3	237.6
Linear Shrinkage in Unrestrained Areas (Percent)		0.22%					
Coefficient of Thermal Expan	75° F.-200° F.	2.74×10^{-5} in/in/°F					
	23.9° C.-93.3° C.	4.93×10^{-5} cm/cm/°C					

How to Use 604 MACHINE BOND



The performance of any epoxy grout application will be substantially dependent upon the attention given to: (1) Proper preparation of the surfaces to which the grout is to be applied; (2) Careful and adequate forming; (3) Strict adherence to mixing and placing instructions; (4) Temperature of the work area and the surface to which the grout is applied; and, (5) Temperature of the grouting material before, during, and after application. For best results, consult our brochure "Specifications for Grouting Heavy Machinery and Production Equipment With No. 604 MACHINE-BOND Epoxy Resin Grout."

Surface Preparation.

All surfaces to be bonded must be dry, sound, and free from any contamination or foreign matter. Concrete surfaces should be prepared by mechanical abrasion such as chipping, bush hammering, sandblasting, or similar methods. A rough surface will aid adhesion. Sandblasting is recommended in preparing metal surfaces.

Forming.

604 MACHINE BOND is a "flowing" grout and must be retained within forms until cured. Forms must be of adequate strength, properly braced, and sealed watertight against leakage. Forms must be coated with a suitable release agent such as paste wax, vegetable shortening, or plastic sheeting to permit their removal after the grout has set.

Forms should allow for hydraulic head as needed to facilitate the filling of the grout bed area.

Mixing and Placing.

Strict adherence to instructions printed on the container is essential. Consult our brochure "Specifications for Grouting Heavy Machinery and Production Equipment With No. 604 MACHINE-BOND Epoxy Resin Grout" for detailed instructions.

All surface preparation and forming must be done before mixing procedures are started. Have all necessary material and equipment for mixing, placing, and clean-up on hand before mixing the grout.

Clean-up.

All equipment, machinery, or floor surfaces which have been in contact with 604 MACHINE BOND must be cleaned before expiration of the epoxy grout working time. Flushing with water or Carter-Waters' PC-700 solvent is recommended for cleaning tools and mixing equipment. Floor and machinery surfaces may be cleaned with Carter-Waters' PC-700 solvent.

TEMPERATURE FACTORS AFFECTING GROUTING

The temperature of all components of 604 MACHINE BOND, Parts A, B, and C, should be at least 70-75° F. (21.1-23.9° C.) before mixing to produce a readily self-leveling grout with good flowability. Mixing grout materials when their temperatures are below or at the low end of the indicated ranges adversely affects good mixing and good flowability of the grout. The grout materials should be stored at a temperature within the ranges indicated.

604 MACHINE BOND "Accelerated" is to be used only where the work area temperatures are 50-70° F. (10-21.1° C.) Table 2 indicates the average working time and curing time which may be expected for 604 MACHINE BOND and 604 MACHINE BOND "Accelerated" Grout. These temperature ranges are also those recommended for application. (For installations outside the temperature ranges indicated in Table 2, contact the Carter-Waters Corporation.) The cure time indicates when load may be applied on the grout bed.

THE TEMPERATURE OF THE GROUT BED SHOULD NOT CHANGE MORE THAN 40° F. (22.2° C.) DURING INITIAL CURE AND FOR 30 DAYS THEREAFTER.

TABLE 2

Average Working and Curing Time (in hours)

604 MACHINE BOND

Work Area Ambient Temperature	°F	50	55	60	65	70	75	80	85	90	95	100
	°C	10	12.8	15.6	18.3	21.1	23.9	26.7	29.4	32.2	35	37.8
Working Time		—	—	6	5	4	3½	3	2½	2	1½	1
Curing Time		—	—	60	55	45	40	36	30	25	20	15

604 MACHINE BOND "ACCELERATED"

Work Area Ambient Temperature	°F	50	55	60	65	70	75	80	85	90	95	100
	°C	10	12.8	15.6	18.3	21.1	23.9	26.7	29.4	32.2	35	37.8
Working Time		6	5	4	3	3	—	—	—	—	—	—
Curing Time		60	55	45	40	36	—	—	—	—	—	—

POOR

QUALITY

ORIGINAL